

"KINGDOM OF THE BLUE WHALE" AIRS MARCH 8 ON NATIONAL GEOGRAPHIC CHANNEL

NATIONALGEOGRAPHIC.COM/MAGAZINE | MARCH 2009

NATIONAL GEOGRAPHIC

Saving Energy

IT STARTS AT HOME



Canadian Oil Boom 34 China's Mystic Waters 82

Sinai: Separate Peace 98 Path of the Jaguar 122 The Greatest Whale 134



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NATIONAL GEOGRAPHIC

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An Egyptian and his Russian girlfriend are among the spring visitors to the Sinai's Ras Shaitan, scene of a 2004 bomb attack. Story on page 98.

MATT MOYER

NATIONAL GEOGRAPHIC

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An infrared camera reveals red hot spots and cool blues at a 1910 Connecticut house.

Photo by Tyrone Turner



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➤ **Sand Trap**
Squeezing oil from tar sands has transformed Alberta, Canada. See the land and listen to the residents to learn how.

PETER ESSICK; REBECCA HALE; NG STAFF (PHONE PAD)

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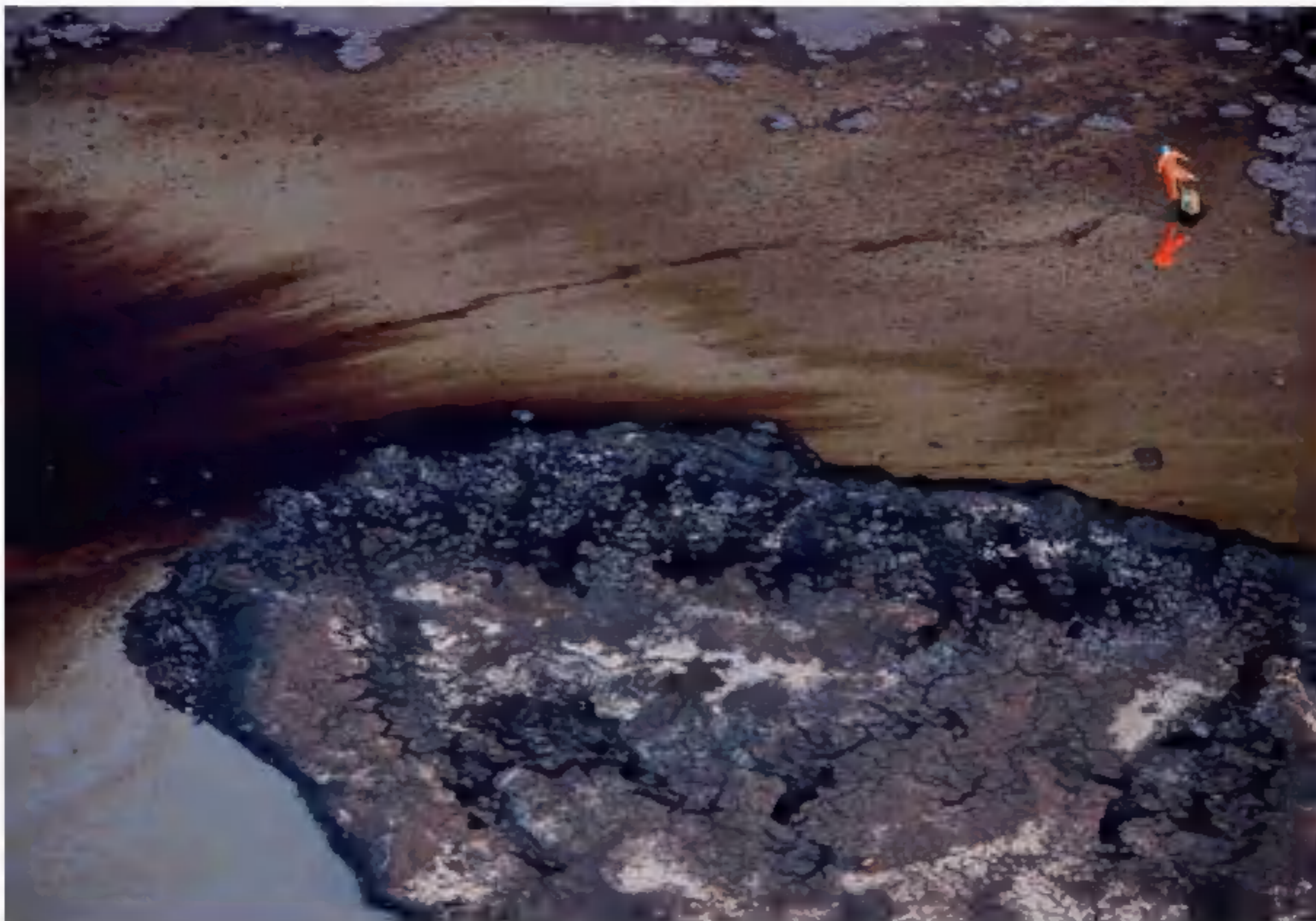


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EDITOR'S NOTE



An orange-clad scarecrow deters birds from landing on a tailings pond in Alberta, Canada.

“There is no feast which does not come to an end,” a Chinese proverb warns, and this month’s story on Canadian oil sands is a cautionary tale about the consequences of large appetites. With the decline of conventional oil reserves and the rising price of oil extraction, sources like oil sands—layers of tarlike bitumen mixed with clay, sand, and water—are increasingly attractive as a way to satisfy the world’s craving for hydrocarbons. The catch: Extracting them is messy and costly to the environment.

All the more reason to be mindful of the choices we make. Nearly 20 years ago my wife, Elizabeth, and I chose to live in the country, which makes us highly dependent on a car. We could move to the city and use mass transit, but we want to raise our family in the country. In compensation for our choices, Elizabeth drives a small, high-mileage car, while I commute to Washington once a week, park, take the subway, walk, and stay with a relative.

Much in life revolves around balance. Public policy strives to balance individual needs and freedoms with community welfare. Canadian oil sands, says author Robert Kunzig, are about balancing the needs of today and tomorrow.

In my own personal quest for balance, it occurs to me that I could compensate for my rural lifestyle by purchasing carbon offsets, but, really, the best strategy is to live an environmentally responsible life to begin with.



This is not just a car. It's a vision of our future.

This is the Chevy Volt. Yes, it's a car, but it's so much more than that. It's a glimpse of what is to come from General Motors as we begin our second century. The Volt will change the way we drive. How? For starters, it will use electricity. And for up to the first 40 miles of driving, it will use zero gasoline and produce no emissions. For longer trips, the Volt's gas-powered range-extending engine will be used strictly to generate more electricity. As we see it, electricity is just one of many paths to the future of transportation. And the Volt is the first step toward completely reinventing the automobile.



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European Mink (*Mustela lutreola*)

Size: Head and body length, 19 - 21.6 cm (7.5 - 8.5 inches); tail, 12 - 17.6 cm (4.7 - 6.9 inches)

Weight: 450 - 1,005 g (1 - 2.2 lbs) **Habitat:** Semi-aquatic; frequents small rivers with wooded banks and some marsh areas **Surviving number:** Estimated at fewer than 10,000



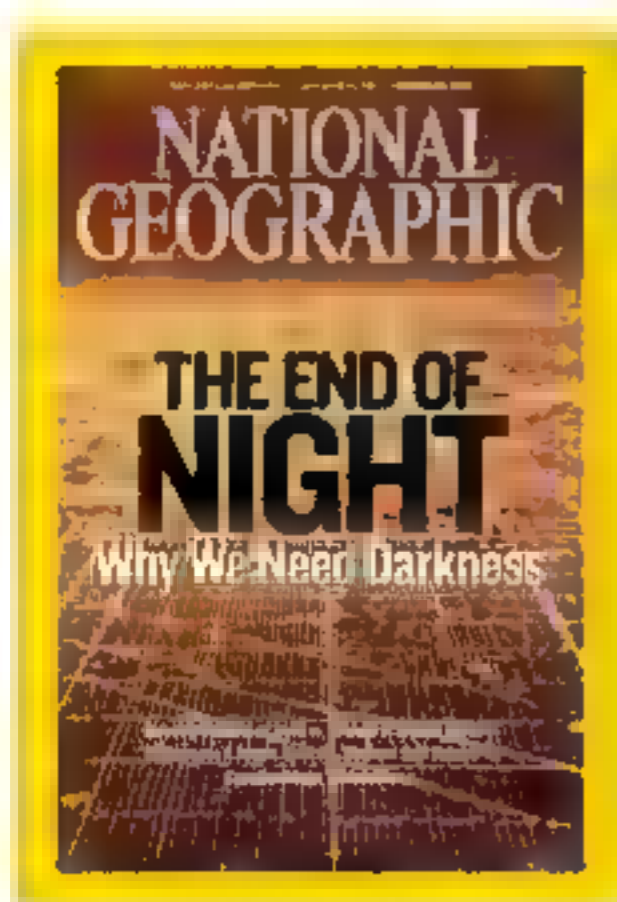
Photographed by Florian Möllers

WILDLIFE AS CANON SEES IT

Thinking mink? Then think water. One of only two native European carnivore species adapted for semi-aquatic life, the European mink is rarely found more than 100 yards from water. The male breeds with females within the territory he holds, generally near a small river or marsh. All the minks take advantage of the rich variety of prey living in or around the water, from fish and frogs to crayfish and small mammals. But mink-friendly habitat is being lost or

degraded at an alarming rate, and in much of what remains the European mink faces competition for food and territory with the introduced American mink. Space, and perhaps time, is running out.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit ngm.com/canonwildlife to learn more.



November 2008

Our Vanishing Night

I gazed at the cover of the November 2008 edition and wondered, How much energy is wasted lighting nighttime Chicago? Multiply that across the number of towns and cities we have in the U.S. alone, and we might see one reason we are such heavy energy users in this country. Often we hear admonishments telling private citizens to conserve our electrical energy, but observe our government bodies wasting it. Unless public agencies set the example and show by their own behavior what needs to be done, citizens will balk at advice given with the old adage implied, Do as I say, not as I do.

ROGER BARTLEY
Richmond, Kentucky

When my granddaughter was three years old, her mom and I took her camping. Bundled up away from the campfire, with millions of stars in that black night, we watched the moonrise. Maddie, who had never seen these phenomena away from city lights, turned her little face to my daughter and said, "Momma! The world is real!" Thank you for the article about the human need

for darkness. The child said it all; for her, the celestial darkness made the world real.

JOY ANDERSON
Salt Lake City, Utah

I was brought up in south London in World War II during the months of the blitz. The nights were always black and clear, allowing stars and the moon to be seen easily. Also, searchlights and ack-ack (and finding the shrapnel the morning after) were a source of great fun for me and my brother, but now I realize they were a dreadful concern to my elders. "Bomber Moon," though fine for us children trying to see our way to the shelter, must have been real anguish for everyone else. I could hear the bombers but never saw them. What was frightening to me was when the streetlights came on at the end of the war. Literally overnight my happy, dark night scene became an eerie place full of strange shadows hiding all sorts of bogeymen.

KEN PYE
Toddington, England

After Hurricanes Frances and Jeanne hit South Florida in 2004, we were without power. The one benefit was the night sky that seemed to suddenly appear out of nowhere. It was dizzying and awesome. We were sad to see the stars disappear as power returned slowly. You don't know what you have till it's gone.

TIM KELLY
West Palm Beach, Florida

Here in Florida, especially the area around Tampa where I live, I have seen my precious starry skies almost disappear over the

years. I wish I could get our big power company to shade their streetlights so I could really see Orion and the Big Dipper again. People are obsessed with lighting up the night, whether for decorative purposes or in the misguided belief that ever burning porch lights equal safety. They are consuming more fossil fuels and wasting more of their money than they realize. Meanwhile our planet's animal species (not to mention we humans) suffer from manipulation of our day/night biorhythms as we are bombarded with more and brighter night lighting everywhere we turn. God created both day and night for a reason. Mankind, it seems, is intent on overruling him and erasing his wondrous, heavenly lights.

RON THUMLER
Tampa, Florida

In June 2004 I was on a bus tour in Huatajata, Bolivia, on the shore of Lake Titicaca at 12,500 feet, far from any city lights. We spent the evening viewing the night sky at the resort's observatory. What a thrill to see the Milky Way with its millions of stars as I did when I was ten, 70 years ago. I have lived here for 80 years, and now it is hard to find one hundred stars on a clear night.

WILLIAM MESSINGER
North Huntingdon, Pennsylvania

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LETTERS

As an organist for the Church of Jesus Christ of Latter-day Saints, serving in the Bountiful, Utah, temple for almost 12 years, I was surprised to see in your article a picture of that temple using ■ long photo exposure to exaggerate its brilliance. I enjoy camping in the mountains to escape the city lights and see the brilliant night sky. If the intent in showing the temple was to capture the beauty of that magnificent structure, then you have an outstanding photograph. But if you were vilifying the lighting, you failed to mention that the lights go out at 10 p.m. every night. Perhaps other sources of light pollution could adopt the same policy.

KAREN ALLGOOD
Nashua, New Hampshire

I'm a resident of the first International Dark Sky City, and so I experience the benefits of the unpolluted night. With ■ light ordinance, the innate patterns of night and the need for sleep have no intrusions. We need to reduce light pollution not only for astronomy and the preservation of the natural ecosystem, but also for the health of society. Lifestyles increasingly operate 24/7. The sacred retreat of the night is lost, and with constant light infiltration, the human body loses vital rest. We need the balance of night and day just as much as our fellow creatures. Seeing only the benefits of longer workdays and artificially prolonged days ignores the negative consequences and disregards the necessity of darkness. Without night, we would burn ourselves out.

SIERRA ECKERT
Flagstaff, Arizona

I was struck by author Verlyn Klinkenborg's disapproval of what I have always thought of as a beautiful thing. Perhaps the most awe-inspiring sight I have seen was when I was on an airplane. Spread out below me was a twinkling field of lights, sparkling under the night sky like a sea of jewels. I similarly found the pictures of the nighttime cities to be just as beautiful as the pictures of the stars. And where the author seems to see an example of human hubris, I see a humbling statement about how far our technology, and our civilization, have progressed.

STEVEN BENNETT
Columbia, South Carolina

When my wife and I purchased furniture recently, we were offered an incredible number of items made from "sustainable" Indonesian hardwoods, invariably with no documentation to authenticate the claim.

Borneo's Moment of Truth

When my wife and I purchased furniture recently, we were offered an incredible number of items made from "sustainable" Indonesian hardwoods, invariably with no documentation to authenticate the claim. Without suitable regulation,

small-scale sustainable use will become ■ smoke screen for large-scale illegal logging.

MIKE WILLIAMS
Ystradfellte, Wales

Thank you for calling attention to the devastating effects of palm oil plantations and other extractive industries on Borneo. In addition to the environmental destruction mentioned in your article, Borneo's palm oil rush is taking a heavy toll on indigenous communities that have sustainably farmed the forests for generations. The United Nations has estimated that five million indigenous people in the Indonesian part of Borneo will lose their homes, land, or livelihood if biofuel crops continue to expand. The struggles of these communities concern me as an American consumer. American agribusiness giants are major importers of Malaysian palm oil. These corporations claim to be meeting U.S. consumer demand for "greener" fuels, but few consumers would condone the practices witnessed in Malaysia. Agribusinesses rely as much on Americans' ignorance of their practices as on the indigenous communities' lack of power to stop them.

DEBRA ERENBERG
Organizing Director
Rainforest Action Network
San Francisco, California

Corrections, Clarifications

November 2008:
Our Vanishing Night
Page 112: The photo of the globe-shaped light fixture was taken on Simcoe Street in Toronto's entertainment district.

ALL DOGS HAVE THEIR DAY (WE RECOMMEND FRIDAY NIGHTS)



DOG WHISPERER
FRIDAYS 8P

DOGTOWN
FRIDAYS 9P



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Debra Loumakis Cumming, Georgia

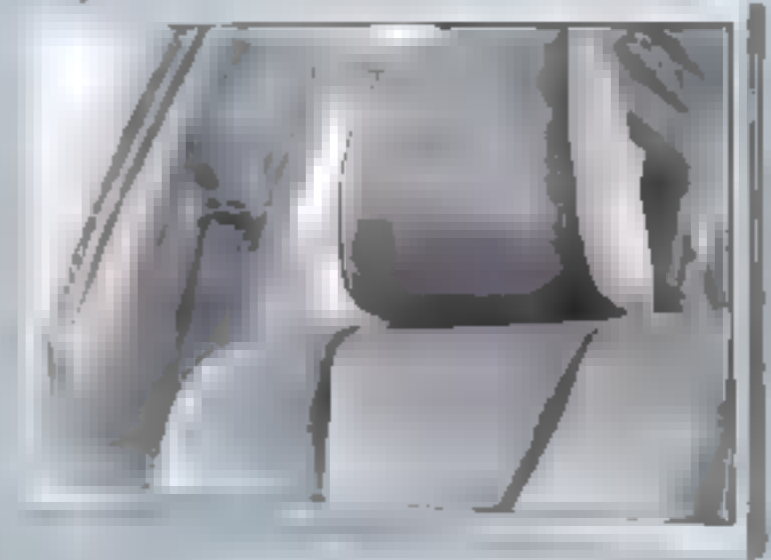
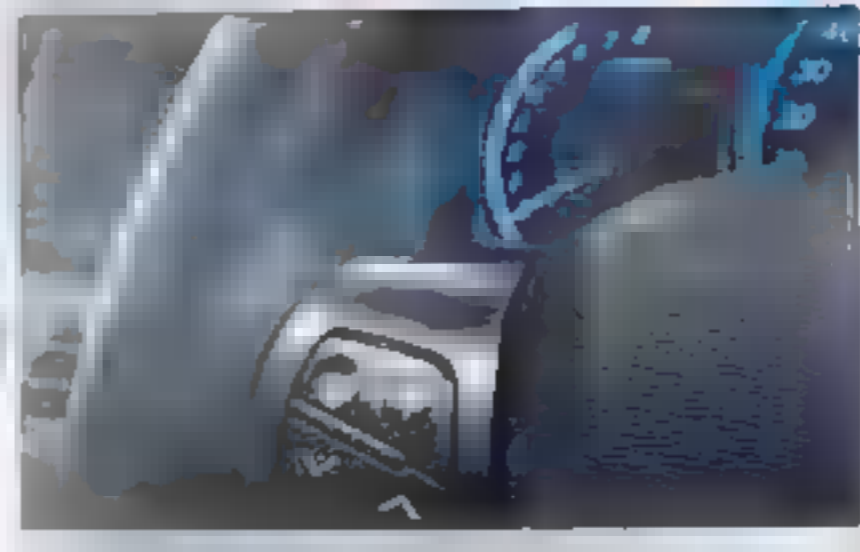
Debra Loumakis's grandson eagerly awaited the arrival of his new sister, who was born a month after this photo was taken. "He loved talking to his mom's belly, and now the baby just loves looking at him and hearing his voice," says Loumakis, 51.

Vashlsta Pathak Dhanbad, India

Walking in his garden one morning, Vashlsta Pathak snapped this photo of a sow thistle, which was voted an *ngm.com* favorite. "A gust of wind blew away half the seeds, which made a perfect shot for me," says the 21-year-old student.



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Dressed for a traditional dance, Melisa Ramirez, a Wayuu Indian, feels the breeze in La Guajira, Colombia.

Scott Dalton has spent two years working on the photo project *Macondo: Journeys in García Márquez's Colombia*.

Another Colombia If you want words to describe life on Colombia's Caribbean coast, read Gabriel García Márquez. The novelist was born and raised there, and his work, including *One Hundred Years of Solitude*, has made the region famous. But if you want to see some of the places that inspired his writing and meet some of the real people who live there, maybe I can help. I've worked as a photojournalist in Colombia since 1999. After years of covering so much that is wrong with the country, I wanted to focus on what is right: the Colombian people, who are the most open and engaging I have ever met. I tried to photograph a reality, their reality, that to me is magical. I hope I do them justice.



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Boxing keeps boys busy in coastal Colombia—and success in the sport can offer a way out of poverty for a lucky few. Ten-year-old Dwais Alberto Payaras (above) trains at a youth boxing club in the Cartagena barrio known as Pie de Cerro.

In the town of Santo Tomás, an annual Holy Week procession features penitents who practice self-flagellation as they walk a ceremonial route. Though the Catholic Church repudiates the ritual, Rafael Torres (right), 63, has participated in the procession for more than 30 years.





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STAR ALLIANCE MEMBER





Crowned as *Reina Popular Gay* of the Barranquilla Carnival, Carlos Ortiz (above, at center) rests after the annual parade with his royal court: brother Steven Ortiz (at left) and Hans Caballero. The celebration in Barranquilla, held in February or March, is one of the biggest carnivals in South America.

Katherine Maestre (right), 16, joins classmates in Aracataca—birthplace of Gabriel García Márquez—at a high school graduation party. In 2006 the town considered a measure to change its name to Aracataca-Macondo, after the fictional setting of *One Hundred Years of Solitude*. The referendum did not pass.



This is no walk in the park if you have Diabetic Nerve Pain.



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Unlike some common over-the-counter pain relievers, Lyrica is FDA approved specifically to treat the **shooting, stabbing, burning sensations** of diabetic nerve pain. Lyrica is believed to help calm the damaged nerves† and help ease this pain – so a walk in the park can be just that.

Ask your doctor if Lyrica can help you.

*Diagram is illustrative of diabetic nerve pain.

† Exact mechanism of action and relevance to humans are unknown as studies were conducted on animal models.

Prescription Lyrica is not for everyone. Tell your doctor right away about any serious allergic reaction that causes swelling of the face, mouth, lips, gums, tongue or neck or affects your breathing or your skin. Also tell your doctor about any changes in your eyesight, including blurry vision, muscle pain along with a fever or tired feeling, skin sores due to diabetes or if you are planning to father a child. Some of the most common side effects of Lyrica are dizziness and sleepiness. Others are weight gain, blurry vision, dry mouth, feeling “high,” swelling of hands and feet and trouble concentrating. You may have a higher chance of swelling, hives or gaining weight if you are also taking certain diabetes or high blood pressure medicines. Do not drive or operate machinery until you know how Lyrica affects you. Do not drink alcohol while taking Lyrica. Be especially careful about medicines that make you sleepy. If you have had a drug or alcohol problem, you may be more likely to misuse Lyrica. Talk with your doctor before you stop taking Lyrica or any other prescription medication.

Please see Important Facts Brief Summary on adjacent page.

To learn more visit www.lyrica.com or call toll-free 1-888-9-LYRICA (1-888-959-7422).

You are encouraged to report negative side effects of prescription drugs to the FDA.

Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

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IMPORTANT FACTS

LYRICA
PREGABALIN
capsules

(LEER-i-kah)

IMPORTANT SAFETY INFORMATION ABOUT LYRICA

LYRICA may cause serious allergic reactions.

Call your doctor right away if you think you have any of the following symptoms of a serious allergic reaction:

- Swelling of the face, mouth, lips, gums, tongue or neck
- Have any trouble breathing
- Other allergic reactions include rash, hives and blisters

LYRICA may make you feel dizzy or sleepy.

- Do not drive a car, work with machines, or do other dangerous things until you are sure you will be alert. Ask your doctor when it is okay to do these things.

LYRICA may cause problems with your eyesight, including blurry vision.

- Call your doctor if you have any changes in your eyesight.

ABOUT LYRICA

LYRICA is a prescription medicine used to treat:

- Nerve pain from diabetes and nerve pain that continues after the rash from shingles heals

This pain can be sharp or burning. It can feel like tingling, shooting, or numbness.

- Fibromyalgia, a condition which includes widespread muscle pain and difficulty performing daily activities

Some people taking LYRICA had less pain by the end of the first week. LYRICA may not work for everyone.

WHO IS LYRICA FOR?

Who can take LYRICA:

- Adults 18 years or older with Fibromyalgia, nerve pain from diabetes, or pain after shingles

Who should NOT take LYRICA:

- Anyone who is allergic to anything in LYRICA

LYRICA has not been studied in children under 18 years of age.

BEFORE STARTING LYRICA

Tell your doctor about all your medical conditions.

Tell your doctor if you:

- Have or had kidney problems or dialysis
- Have heart problems, including heart failure
- Have a bleeding problem or a low blood platelet count
- Have abused drugs or alcohol. LYRICA may cause some people to feel "high."
- Are either a man or woman planning to have children or a woman who is breast-feeding, pregnant, or may become pregnant. It is not known if LYRICA may decrease male fertility, pass into breast milk, or if it can harm your unborn baby. You and your doctor should decide whether you should take LYRICA or breast-feed, but not both.

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal products. Tell your doctor if you take:

- Avandia[®] (rosiglitazone)^{*} or Actos[®] (pioglitazone)^{**} for diabetes. You may have a higher chance of weight gain or swelling if these medicines are taken with LYRICA.
- Angiotensin converting enzyme (ACE) inhibitors
- Narcotic pain medicines (such as oxycodone), tranquilizers or medicines for anxiety (such as lorazepam). You may have a higher chance for dizziness and sleepiness if these medicines are taken with LYRICA.
- Any medicines that make you sleepy

POSSIBLE SIDE EFFECTS OF LYRICA

LYRICA may cause serious side effects, including:

- Serious allergic reactions. See "Important Safety Information About LYRICA" for a complete description of the symptoms of a serious allergic reaction.
- Dizziness and sleepiness
- Eyesight problems including blurry vision
- Weight gain and swelling of hands and feet. Weight gain may affect control of diabetes. Weight gain and swelling can be serious for people with heart problems.
- Unexplained muscle pain, soreness, or weakness along with a fever or tired feeling
- Skin sores. LYRICA caused skin sores in animals. Although skin sores were not seen in studies in people, if you have diabetes, you should pay extra attention to your skin while taking LYRICA and tell your doctor of any sores or skin problems.

If you have any of these symptoms, tell your doctor right away.

The most common side effects of LYRICA are:

- Dizziness
- Sleepiness
- Weight gain
- Blurry vision
- Dry mouth
- Constipation
- Feeling "high"
- Swelling of hands and feet
- Balance problems
- Trouble concentrating
- Increased appetite

You may have a higher chance of swelling, hives or gaining weight if you are taking certain diabetes medicines or angiotensin converting enzyme (ACE) inhibitors with LYRICA.

Medicines that already make you sleepy or dizzy may make you feel more sleepy or dizzy with LYRICA.

HOW TO TAKE LYRICA

Do:

- Take LYRICA exactly as your doctor tells you. Your doctor may tell you to take it 2 or 3 times a day.
- Take LYRICA with or without food.

Don't:

- Do not drive a car or use machines if you feel dizzy or sleepy while taking LYRICA.
- Do not drink alcohol or use other medicines that make you sleepy while taking LYRICA.
- Do not change the dose or stop LYRICA suddenly. You may have headaches, nausea, diarrhea, or trouble sleeping if you stop taking LYRICA suddenly.
- Do not start any new medicines without first talking to your doctor.

NEED MORE INFORMATION?

- Ask your doctor or pharmacist. This is only a brief summary of important information.
- Go to www.lyrica.com or call:
 - For Nerve Pain: 1-888-9-LYRICA (1-888-959-7422).
 - For Fibromyalgia: 1-888-5-LYRICA (1-888-559-7422).

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Truly Unique



Time travel at the speed of a 1935 Speedster?

The 1930s brought unprecedented innovation in machine-age technology and materials. Industrial designers from the auto industry translated the principles of aerodynamics and streamlining into everyday objects like radios and toasters. It was also a decade when an unequalled variety of watch cases and movements came into being. In lieu of hands to tell time, one such complication, called a jumping mechanism, utilized numerals on a disc viewed through a window. With its striking resemblance to the dashboard gauges and radio dials of the decade, the jump hour watch was indeed "in tune" with the times!

The Stauer 1930s Dashtronic deftly blends the modern functionality of a 21-jewel automatic movement and 3-ATM water resistance with



True to Machine Art esthetics, the sleek brushed stainless steel case is clear on the back, allowing a peek at the inner workings.

the distinctive, retro look of a jumping display (not an actual jumping complication). The stainless steel 1 1/2" case is complemented with a black alligator-embossed leather band. The band is 9 1/2" long and will fit a 7-8 1/2" wrist.

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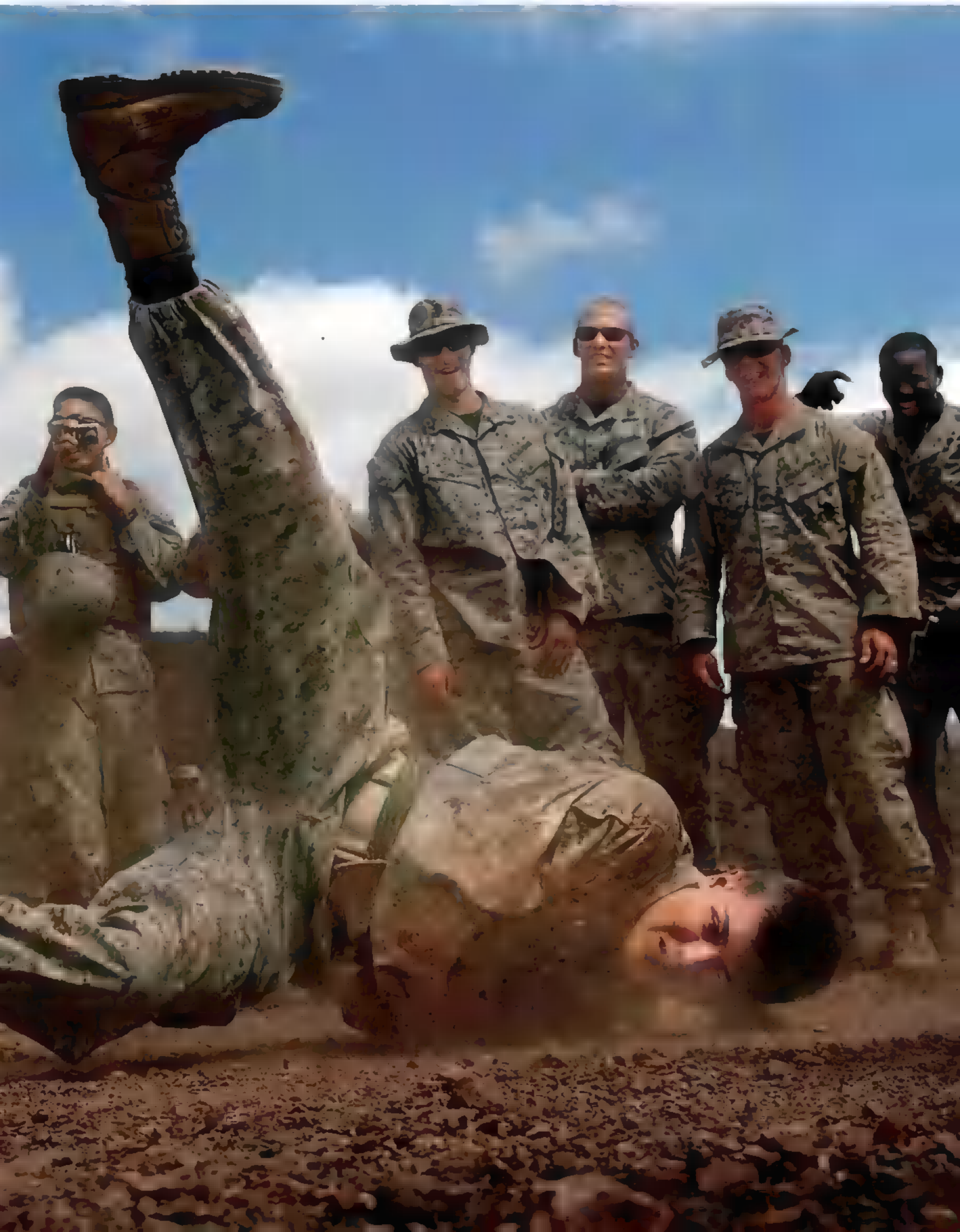
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VISIONS OF EARTH



Djibouti A break in training exercises lets Marine Cpl. Brett Herman try out his break-dancing moves during a “freestyle” contest at Camp Lemonier. The former French barracks is the sole U.S. base on the Horn of Africa.

PHOTO: JEREMY LOCK





Thailand In a race to emerge at the Sriracha Tiger Zoo, one eight-inch Siamese crocodile wins by a head. Few such crocs exist in the wild, yet 20,000 are born each year during the zoo's May-to-August hatching festival.



PHOTO: SUKREE SUKPLANG, REUTERS



Madagascar Sunrise reveals light traffic—a lone oxcart—along the Avenue of the Baobabs. The 80-foot-tall “upside-down trees” in the Menabe region could become the island country’s first national monument.



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PHOTO: MARSEL VAN OOSTEN





The meat of a spiny softshell turtle could end up on a plate or in a bowl in China.



Licensed turtle harvesters Sam Millard (at right) and his father, Fred, bag a shipment at their farm in Holdenville, Oklahoma.

Turtles in Hot Water China's appetite for turtle, served in soups or stews, has emptied rivers and streams across Asia of their terrapin populations. Since the 1990s, consumption rates have soared as newly affluent Chinese splurged on the reptile meat, traditionally associated with health and longevity. To keep it on the menu, Chinese importers have turned to the turtle-rich waters of the United States. Today hundreds of thousands of wild freshwater turtles, primarily softshells and snappers, are being shipped yearly from southern states to Asian countries, especially China.

The buying spree alarms American conservationists, who term the harvest "unsustainable." Because of turtles' slow reproductive rate, the "removal from a stream of even a few adults can have an effect lasting for decades," says Jeff Miller, a conservation advocate at the Center for Biological Diversity.

Last year conservation groups coordinated by the center urged Oklahoma, Texas, Georgia, and Florida—the only remaining states with unregulated harvests—to end commercial turtle gathering. The effort has met with some success. Texas and Oklahoma have halted turtle trapping on public lands, with the possibility of extending the ban to private property. Meanwhile, the center has another petition in the works: to put as many as 12 southern turtle species on the endangered species list before it's too late. —Tom O'Neill

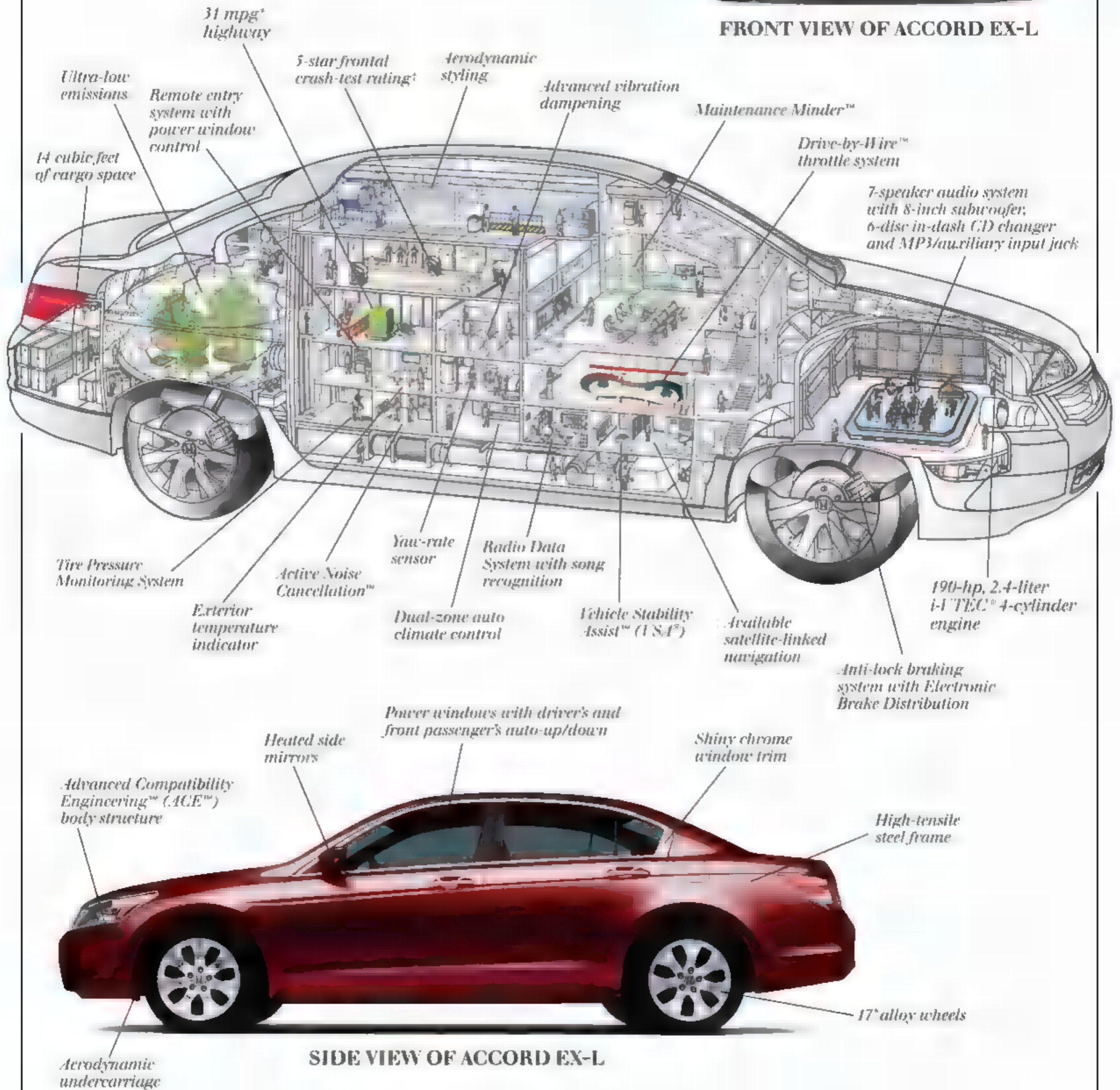
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ARCHAEOLOGY

Left in the Dust Utah's Nine Mile Canyon used to be a serene backcountry destination. You could pull your car over to the side of the road, walk a few steps, and admire up close the pictures—many at least a thousand years old—carved or painted on the towering sandstone walls by the region's ancient residents, the Fremont people. Do that today and you'll dodge big rigs barreling past on their way to service gas wells and pipelines. In 2004 the



U.S. Bureau of Land Management opened Nine Mile to natural gas development. Since then, archaeologists have fretted over the rock art's fate. In 2008 the BLM acknowledged that truck traffic (left) is taking a toll. A study it commissioned found that the steady stream of trucks

has pulverized the canyon's dirt roads, releasing "clouds of fine particulates into the air." Rock art panels are slowly vanishing under the accumulating dust. The BLM is now evaluating possible solutions—as well as a proposal to drill 800 more wells. —Keith Kloor



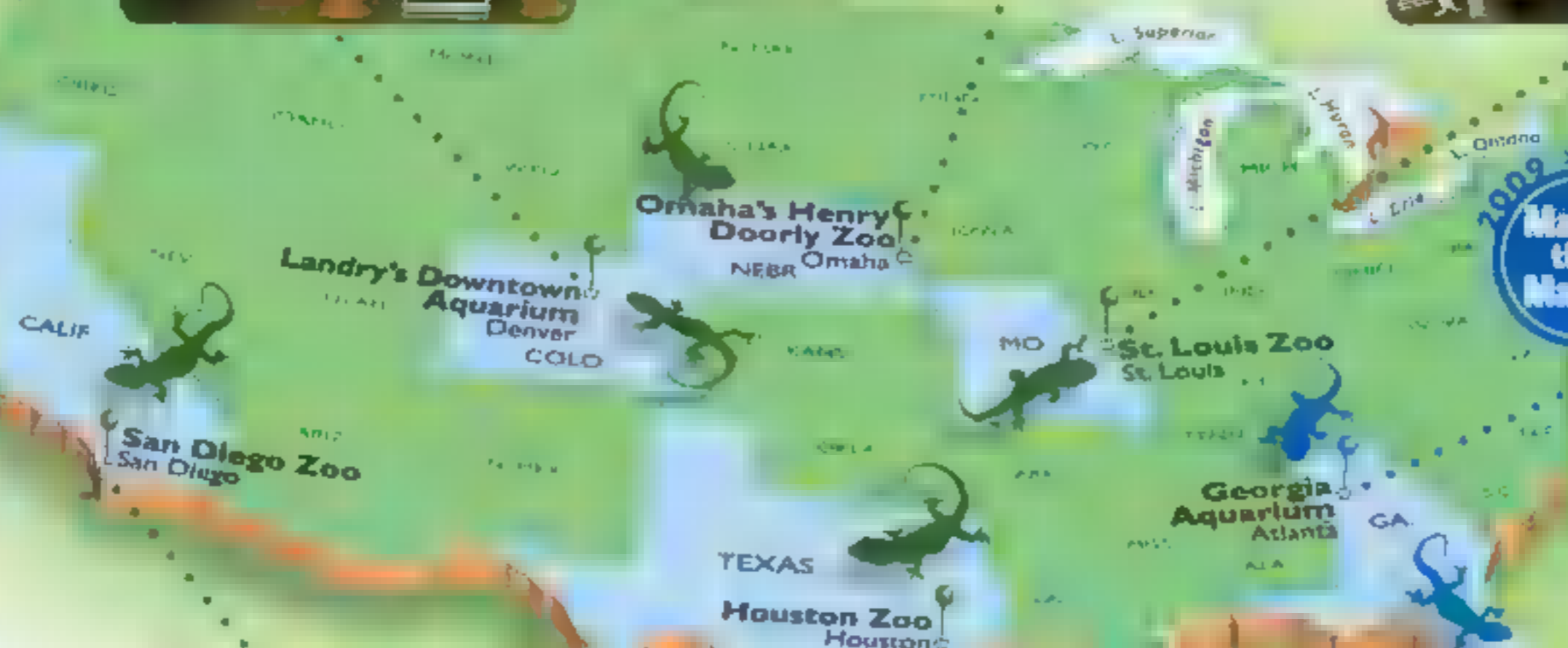
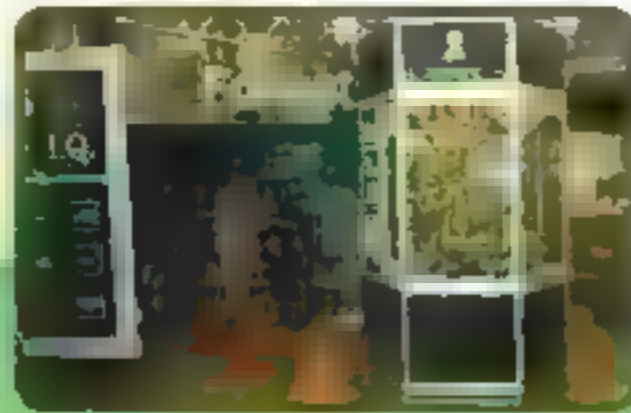
Dust obscures Nine Mile Canyon's Great Hunt panel in a photo made after the area opened to development.

The GEICO Gecko could be coming to a zoo near you.

He's out to help educate the public about how wildlife conservation can keep his mates alive. The exhibit features live geckos and provides important education on the background of geckos, especially those facing extinction.

The Gecko's tour is well under way.

Check out the map below to see where he's already been. New AZA-accredited zoos are being added to the tour, which will run through 2010, so check www.aza.org/Newsroom/PR_GEICO/index.html for the latest updates.



2009 >>> TOUR
Mar. 15
thru
May 30



2009 >>> TOUR
Jan. 15
thru
Mar. 1



GEICO
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More than 2,200 species of geckos exist worldwide. Many are found in tropical and subtropical regions, and some are found in temperate zones. Geckos are found in a wide variety of habitats, from deserts to rainforests, and from high mountains to lowlands. They are found in all parts of the world, except in Antarctica.

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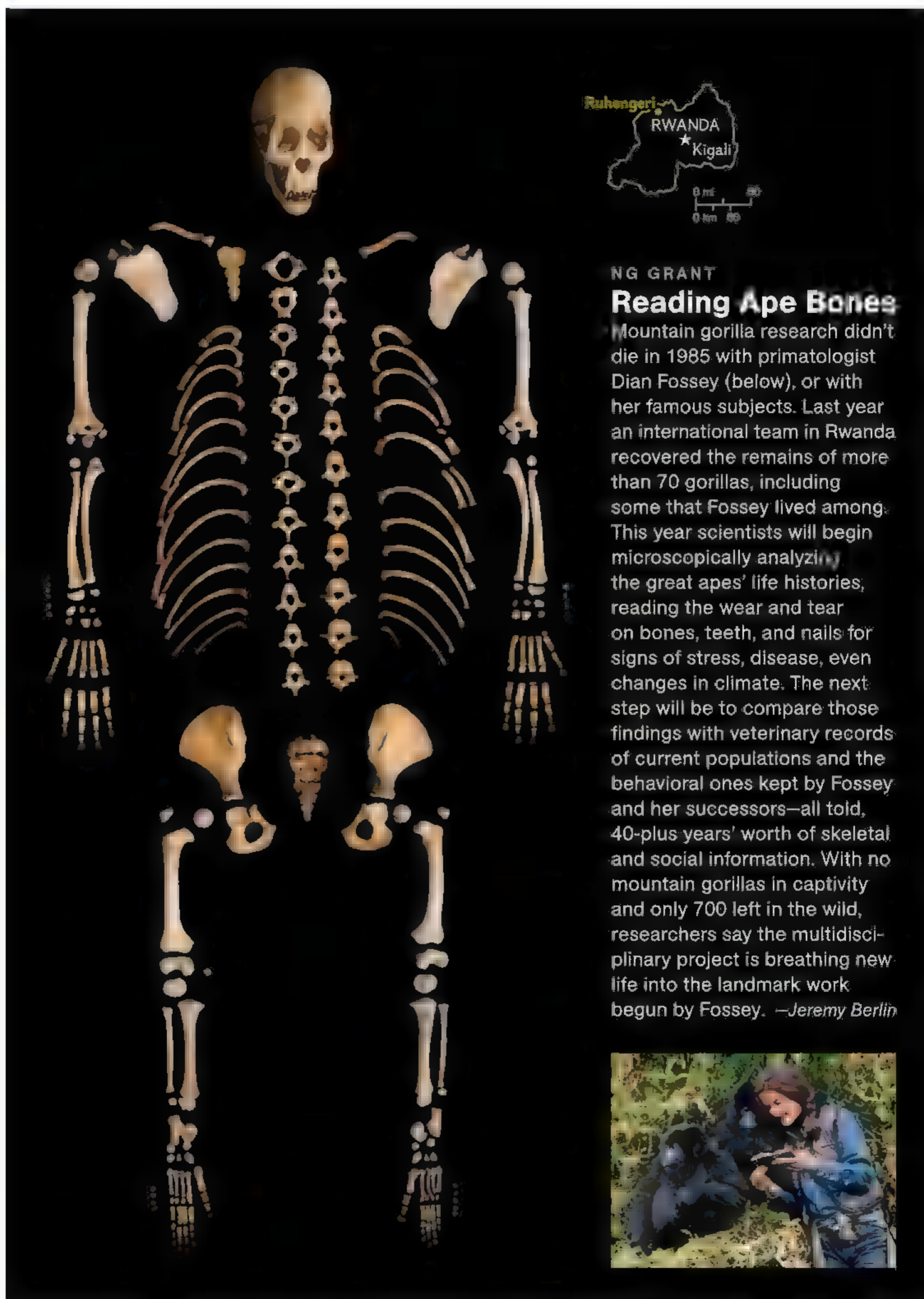
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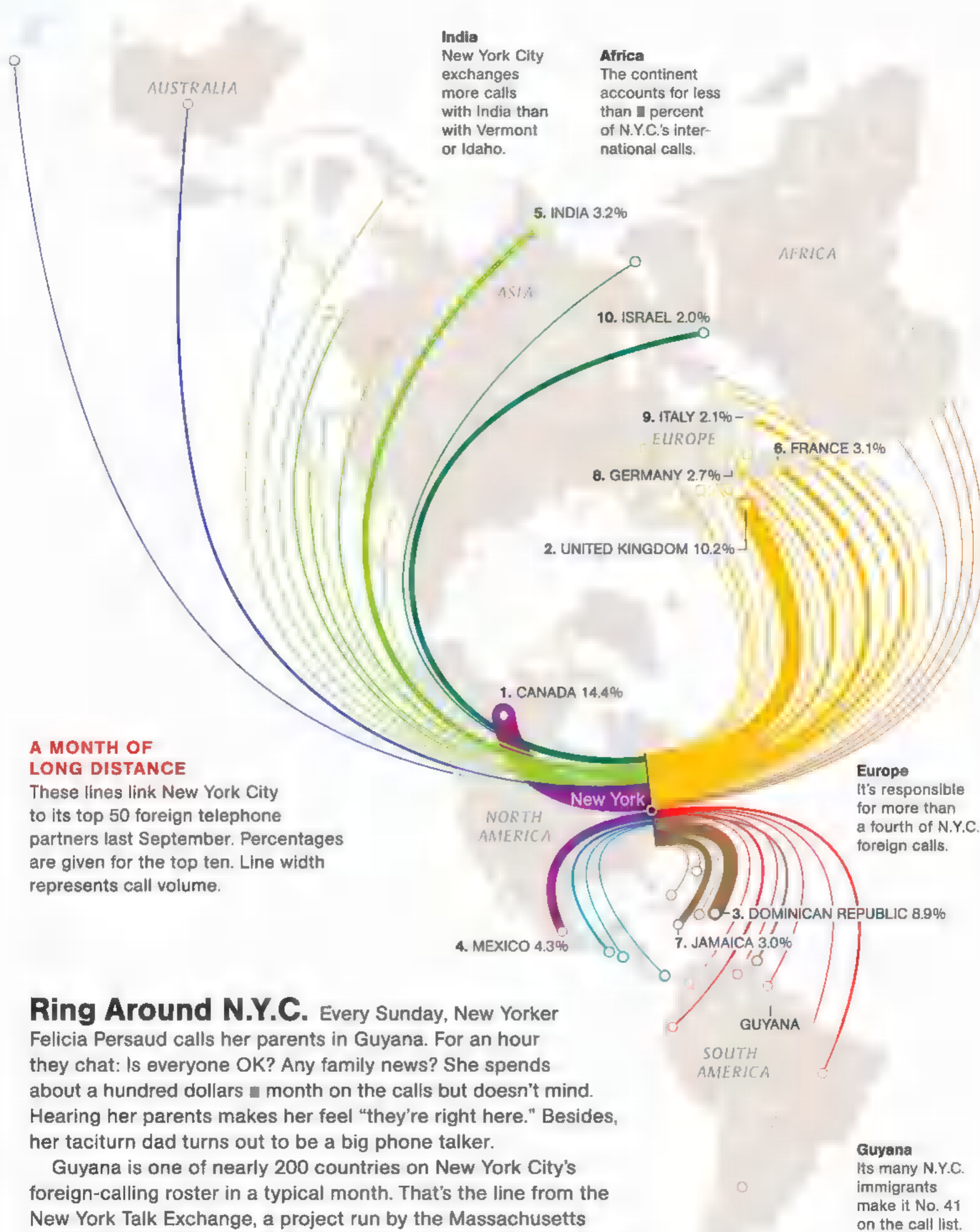
Reading Ape Bones

Mountain gorilla research didn't die in 1985 with primatologist Dian Fossey (below), or with her famous subjects. Last year an international team in Rwanda recovered the remains of more than 70 gorillas, including some that Fossey lived among. This year scientists will begin microscopically analyzing the great apes' life histories, reading the wear and tear on bones, teeth, and nails for signs of stress, disease, even changes in climate. The next step will be to compare those findings with veterinary records of current populations and the behavioral ones kept by Fossey and her successors—all told, 40-plus years' worth of skeletal and social information. With no mountain gorillas in captivity and only 700 left in the wild, researchers say the multidisciplinary project is breathing new life into the landmark work begun by Fossey. —Jeremy Berlin



This mountain gorilla skeleton, pieced together by researchers last summer, is now stored in Ruhengeri, Rwanda.

GEOGRAPHY



A MONTH OF LONG DISTANCE

These lines link New York City to its top 50 foreign telephone partners last September. Percentages are given for the top ten. Line width represents call volume.

Ring Around N.Y.C. Every Sunday, New Yorker Felicia Persaud calls her parents in Guyana. For an hour they chat: Is everyone OK? Any family news? She spends about a hundred dollars a month on the calls but doesn't mind. Hearing her parents makes her feel "they're right here." Besides, her taciturn dad turns out to be a big phone talker.

Guyana is one of nearly 200 countries on New York City's foreign-calling roster in a typical month. That's the line from the New York Talk Exchange, a project run by the Massachusetts Institute of Technology and AT&T Labs. The data offers an "instant view of globalization—and of how beautifully interconnected the world is," says Carlo Ratti, director of MIT's Senseable City Lab. The millions of calls also show that even in an era of email and text messages, folks like the Persauds crave the intimacy of the old-fashioned telephone. —Marc Silver

Hear it from someone who knows.

A tour of the Emberá community in the Bayano river.

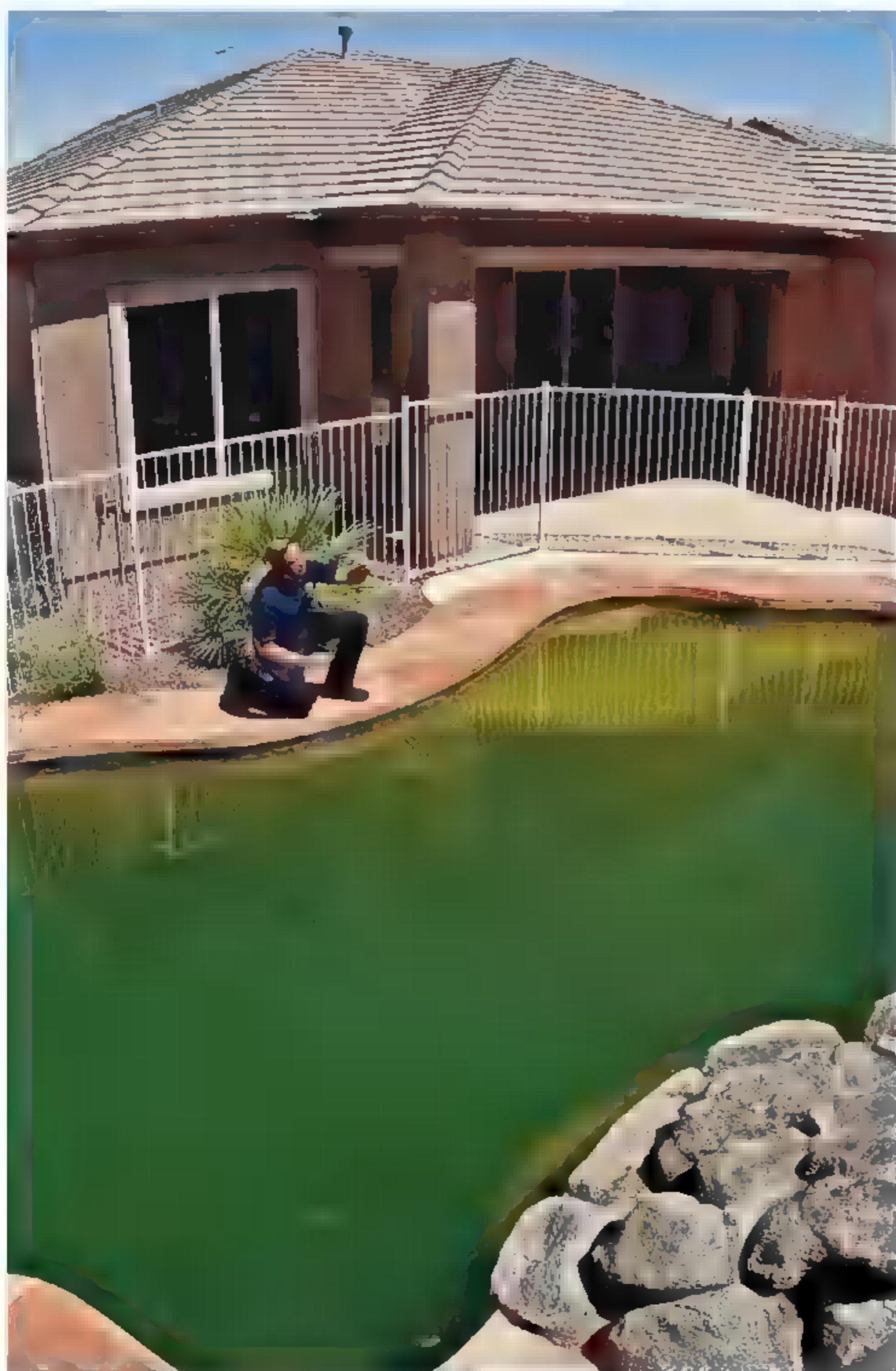


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Mosquito Hosts

Call the automated line at Vector Control in Maricopa County, Arizona, and you'll get a couple of odd options. You can, for example, report a "green pool" or request a bagful of fish.

The "green" refers to algae that builds up after a pool is abandoned. As the financial crisis in the U.S. has deepened, home foreclosures have forced or frightened many homeowners into leaving their property. Untended pools, ponds, and Jacuzzis stagnate—and become breeding grounds for mosquitoes that could carry diseases such as West Nile Virus.

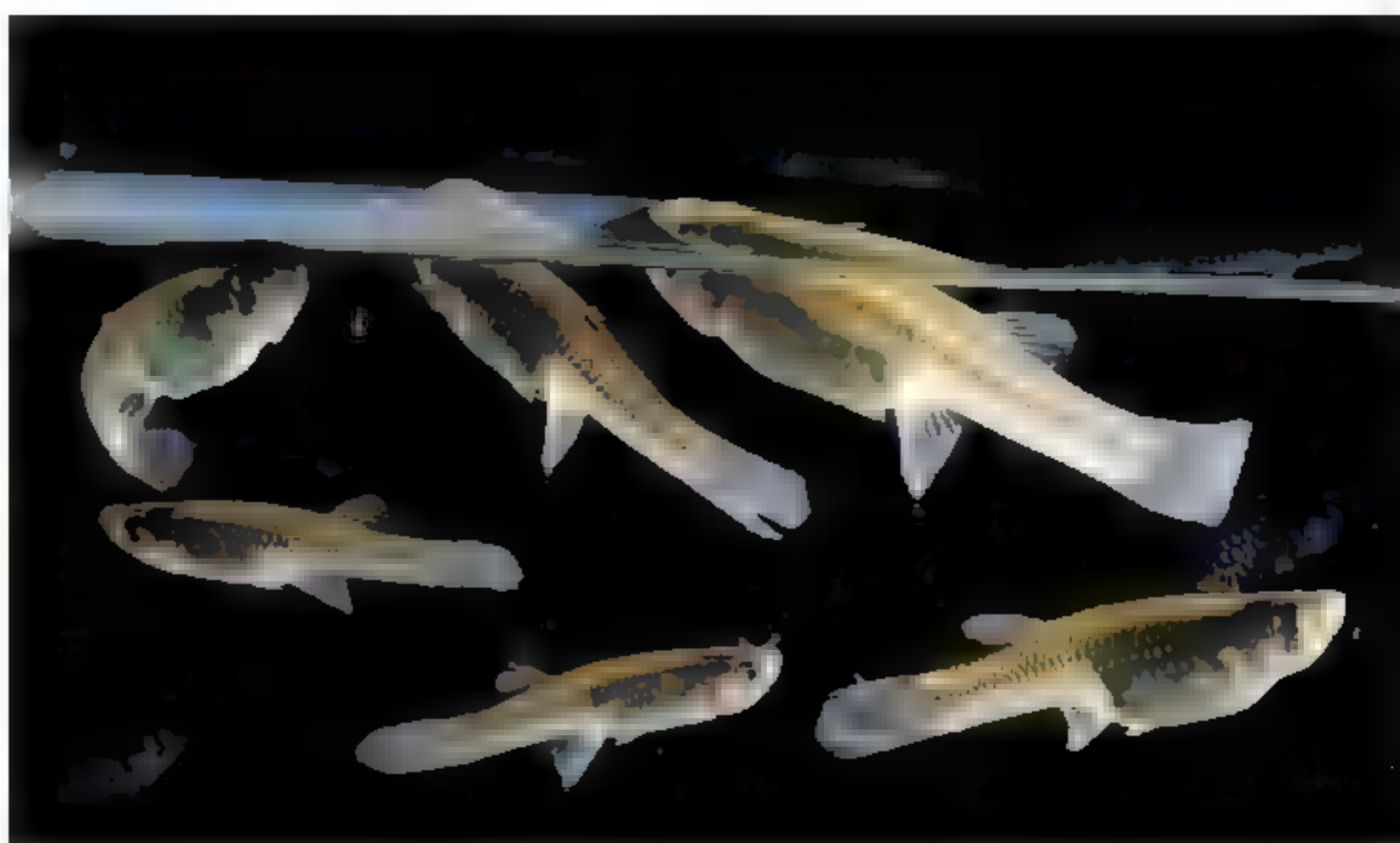
Antimosquito chemicals work for one to five months, depending on the dose. A longer lasting method relies on fish: tiny ones related to guppies and aptly called mosquito fish. In open water, the predators can wipe out native fish. In an enclosed body of water, they devour mosquitoes. Several states give the fish to property owners or pour them into green pools. A single fish can eat hundreds of larvae a day. —Neil Shea

▲ THE PROBLEM

High rates of home foreclosure mean pools are abandoned, like this one in Chandler, Arizona. Algae turns the water green. Debris drops in. So do mosquitoes.

▲ A SOLUTION ►

Many nations use mosquito fish for insect control. The one- or two-inchers are fairly cheap and live up to two years, even in a low-oxygen environment. A single female can deliver at least a hundred fry a season.





About 1.6 million people die of tuberculosis (TB) each year¹ mostly in developing nations lacking access to fast, accurate testing technology.

TB is the current focus of the Foundation for Innovative New Diagnostics (FIND), established with funding from the Bill and Melinda Gates Foundation. FIND is dedicated to the advancement of diagnostic testing for infectious diseases in developing countries. For more information, visit www.finddiagnostics.org.



A young girl reveals hope in India, which carries one-fifth of the global burden of TB.



Helping all people live healthy lives

Partnering against TB

Twenty-two developing countries carry the burden of 80 percent of the world's cases of TB, the second-leading killer among infectious diseases and primary cause of death among people with HIV/AIDS. The problem is compounded by TB's resistance to drug treatment, limiting the options for over 450,000 patients annually.

BD is pleased to work with FIND to provide equipment, reagents, training and support to the public health sector in high-burdened countries on terms that will enable them to purchase and implement these on a sustainable basis.

The BD MGIT[™] (Mycobacteria Growth Indicator Tube) system can shorten the recovery of TB in

culture from 42 days to as little as 10-14 days. In addition, by identifying resistance to specific drugs, the BD MGIT[™] system provides fast and reliable information that can help physicians prescribe more effective treatments. All this can contribute to the reduction in spread and mortality of TB, particularly in the HIV/AIDS population, where it is especially difficult to diagnose.

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BD – Helping all people live healthy lives.

¹ Source of all statistics cited: StopTB/World Health Organization, 2007.

² FORTUNE, March 2008

³ Ethisphere[®] Magazine, June 2008

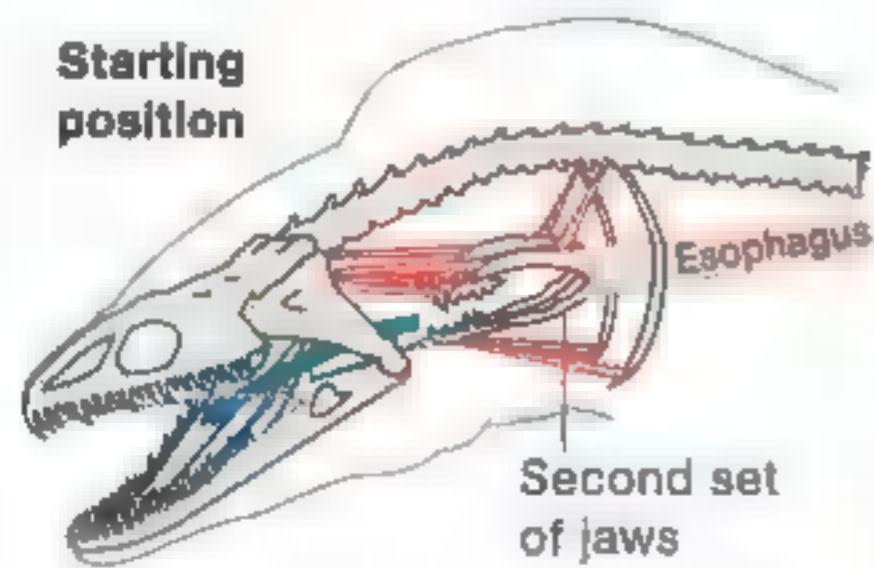
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World TB Day
March 24, 2009

Jaws, Two Pulsing mouth, vacant stare, snakelike body: The moray eel truly suggests alien origins. But there's more. Back behind this giant reef fish's already toothy maw looms a second set of jaws, which launch from the throat, grab prey from the front teeth, then retreat into the dark tunnel of the eel's esophagus. It's the stuff of science fiction. But to scientists studying this unique morphology, it's a brilliant feeding mechanism for such an elongated creature.

Unlike most bony fishes, morays don't seem to generate enough suction to help in swallowing, says Rita Mehta of the University of California at Davis. Instead, the novel dual-jaw arrangement, which she and colleagues recently examined with high-speed video, allows the animals to both restrain and transport big prey—the most efficient nourishment for big animals—down the long throat. This is the first report of such a mechanism in a vertebrate. Though on a different branch of the evolutionary tree, snakes have a related system, ■ set of ratcheting jaws that grip and maneuver food into the gullet. Says Mehta, "It's a wonderful example of convergence"—when distant organisms facing the same problem develop similar solutions. —Jennifer S. Holland



FROM BITE TO BELLY How does a 12-foot-long eel move food down its throat? Sliding rear jaws. After the front jaws bite, the rear ones slide up and grab the prey. As those retract, the front jaws release. The eel then juts its head forward, which aids in the swallowing process.



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Panama's rich bio-diversity allows experts to find bird species from both North and South America, making it an easy and effortless task. Since the 1970s the highest number of 24-hour bird-sighting records have been made in Panama. For more information go to visitpanama.com

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On March 7, 16-dog teams begin the 1,150-plus-mile Iditarod race from Anchorage to Nome, Alaska.

How Dogs Keep On Mushing For years sled-dog racers stuck to a basic long-distance formula: six hours on, six off. Recently, though, teams have won prominent races like the Iditarod by going longer than was thought possible, up to 14 hours at a stretch, with the dogs getting stronger the longer they ran. Clearly ■ tactical rethink and ■ medical reevaluation were in order.

Michael S. Davis, an Oklahoma State University veterinary physiologist, says top sled dogs “seem to flip ■ magic switch,” which somehow changes their metabolism after racing a few hours. That lets them quickly burn lots of calories—about 12,000 a day, from a fat-laden diet—without depleting their muscles’ fat and sugar stores or growing tired. It’s not clear just how they do it, or whether migratory animals have a similar capacity, but Davis hopes to find the “hidden strategy,” then see whether humans have one too.

Musher Jon Little defends testing the endurance of sled dogs, typically huskies and malamutes, for the sake of science. “They run because they love to,” he says, “not because they have to.” Might other breeds have the metabolic switch? That’s best answered by the racer who ran four Iditarods with poodles. —Jeremy Berlin

ENDURANCE TEST

Sled dogs use more energy than other species’ star athletes but don’t seem to feel the burn.

490
Sled dog in Iditarod

Daily energy burned in kilocalories per pound

45
Horse in 3-day event

140
Cyclist ■ Tour de France





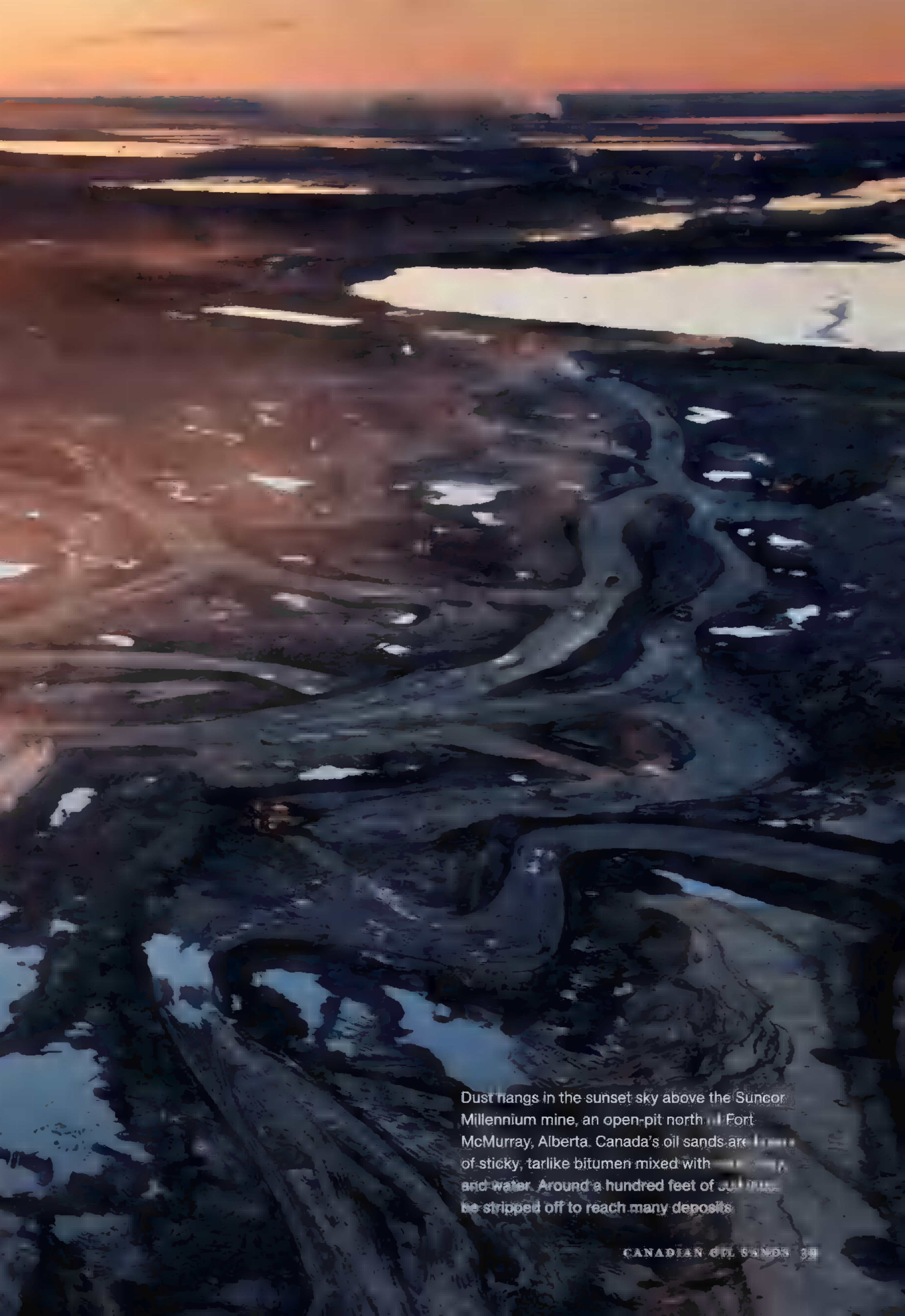




**THE
CANADIAN
OIL
BOOM**

SCRAPING BOTTOM

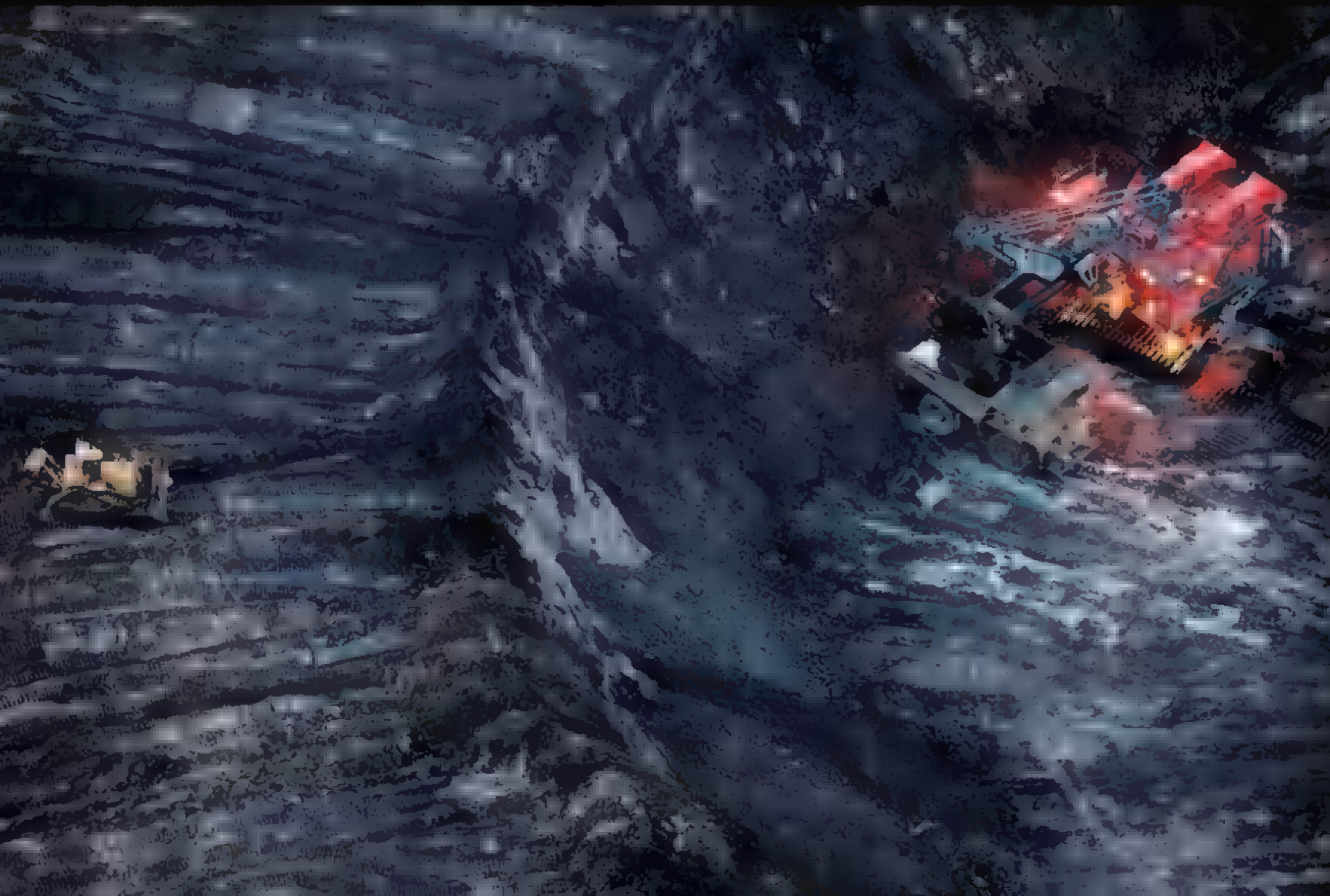
Once considered too expensive, as well as too damaging to the land, exploitation of Alberta's oil sands is now a gamble worth billions.



Dust hangs in the sunset sky above the Suncor Millennium mine, an open-pit north of Fort McMurray, Alberta. Canada's oil sands are layers of sticky, tarlike bitumen mixed with sand and water. Around a hundred feet of soil must be stripped off to reach many deposits.



SQUEEZING SAND FOR OIL Oil sands surface mining operates on extreme scales, with crews working around the clock through hot summers and subzero winters to feed heavy demand. At the bottom of a mine, a giant shovel (below) devours sand and delivers it to trucks like this three-story, four-million-dollar Caterpillar (bottom right), which muscle up to 400 tons at a time to extraction plants.





There bitumen is separated from sand in a hot-water wash. As the bitumen rises to the top of the wash, Suncor employee Lee Flett (above) skims off wood, leaves, and other debris before the sticky load is sent to an upgrading facility that converts it to synthetic crude oil. Sand, water, and bitumen residues are finally piped to a tailings pond (top left), where the water is extracted, cleaned, and reused in the mines.



BY ROBERT KUNZIG

PHOTOGRAPHS BY PETER ESSICK



One day in 1963, when Jim Boucher was seven, he was out working the trapline with his grandfather a few miles south of the Fort McKay First Nation reserve on the Athabasca River in northern Alberta. The country there is wet, rolling fen, dotted with lakes, dissected by streams, and draped in a cover of skinny, stunted trees—it's part of the boreal forest that sweeps right across Canada, covering more than a third of the country. In 1963 that forest was still mostly untouched. The government had not yet built a gravel road into Fort McKay; you got there by boat



The lunch line at one of four Mac's convenience stores in Fort McMurray offers a boomtown snapshot. Most customers are men between 25 and 30 years old, and many work at the mines. Tobacco, sugar-laden drinks, and bags of salty snacks sell briskly.

or in the winter by dogsled. The Chipewyan and Cree Indians there—Boucher is a Chipewyan—were largely cut off from the outside world. For food they hunted moose and bison; they fished the Athabasca for walleye and whitefish; they gathered cranberries and blueberries. For income they trapped beaver and mink. Fort McKay was a small fur trading post. It had no gas, electricity, telephone, or running water.

Those didn't come until the 1970s and 1980s.

In Boucher's memory, though, the change begins that day in 1963, on the long trail his grandfather used to set his traps, near a place called Mildred Lake. Generations of his ancestors had worked that trapline. "These trails had been here thousands of years," Boucher said one day last summer, sitting in his spacious and tasteful corner office in Fort McKay. His golf putter stood in one corner; Mozart played softly on the stereo. "And that day, all of a sudden, we came upon this clearing. A huge clearing. There had been no notice. In the 1970s they went in and tore down my grandfather's cabin—with no notice or discussion." That was Boucher's first encounter with the oil sands industry. It's an industry that has utterly transformed this part of northeastern Alberta in just the past few years, with astonishing speed. Boucher is surrounded by it now and immersed in it himself.

Where the trapline and the cabin once were, and the forest, there is now a large open-pit mine. Here Syncrude, Canada's largest oil producer, digs bitumen-laced sand from the ground with electric shovels five stories high, then washes the bitumen off the sand with hot water and sometimes caustic soda. Next to the mine, flames flare from the stacks of an "upgrader," which cracks the tarry bitumen and converts it into Syncrude Sweet Blend, a synthetic crude that travels down a pipeline to refineries in Edmonton, Alberta; Ontario, and the United States. Mildred Lake, meanwhile, is now dwarfed by its neighbor, the Mildred Lake Settling Basin, a four-square-mile lake of toxic mine tailings. The sand dike that contains it is by volume one of the largest dams in the world.

Nor is Syncrude alone. Within a 20-mile radius of Boucher's office are a total of six mines that produce nearly three-quarters of a million barrels of synthetic crude oil a day; and more are in the pipeline. Wherever the bitumen layer lies too deep to be strip-mined, the industry melts it "in situ" with copious amounts of steam, so that it can be pumped to the surface. The industry has spent more than \$50 billion on construction during the past decade, including some

\$20 billion in 2008 alone. Before the collapse in oil prices last fall, it was forecasting another \$100 billion over the next few years and a doubling of production by 2015, with most of that oil flowing through new pipelines to the U.S. The economic crisis has put many expansion projects on hold, but it has not diminished the long-term prospects for the oil sands. In mid-November, the International Energy Agency released a report forecasting \$120-a-barrel oil in 2030—a price that would more than justify the effort it takes to get oil from oil sands.

Nowhere on Earth is more earth being moved these days than in the Athabasca Valley. To extract each barrel of oil from a surface mine, the industry must first cut down the forest, then remove an average of two tons of peat and dirt that lie above the oil sands layer, then two tons of the sand itself. It must heat several barrels of water to strip the bitumen from the sand and upgrade it, and afterward it discharges contaminated water into tailings ponds like the one near Mildred Lake. They now cover around 50 square miles. Last April some 500 migrating ducks mistook one of those ponds, at a newer Syncrude mine north of Fort McKay, for a hospitable stopover, landed on its oily surface, and died. The incident stirred international attention—Greenpeace broke into the Syncrude facility and hoisted a banner of a skull over the pipe discharging tailings, along with a sign that read “World’s Dirtiest Oil: Stop the Tar Sands.”

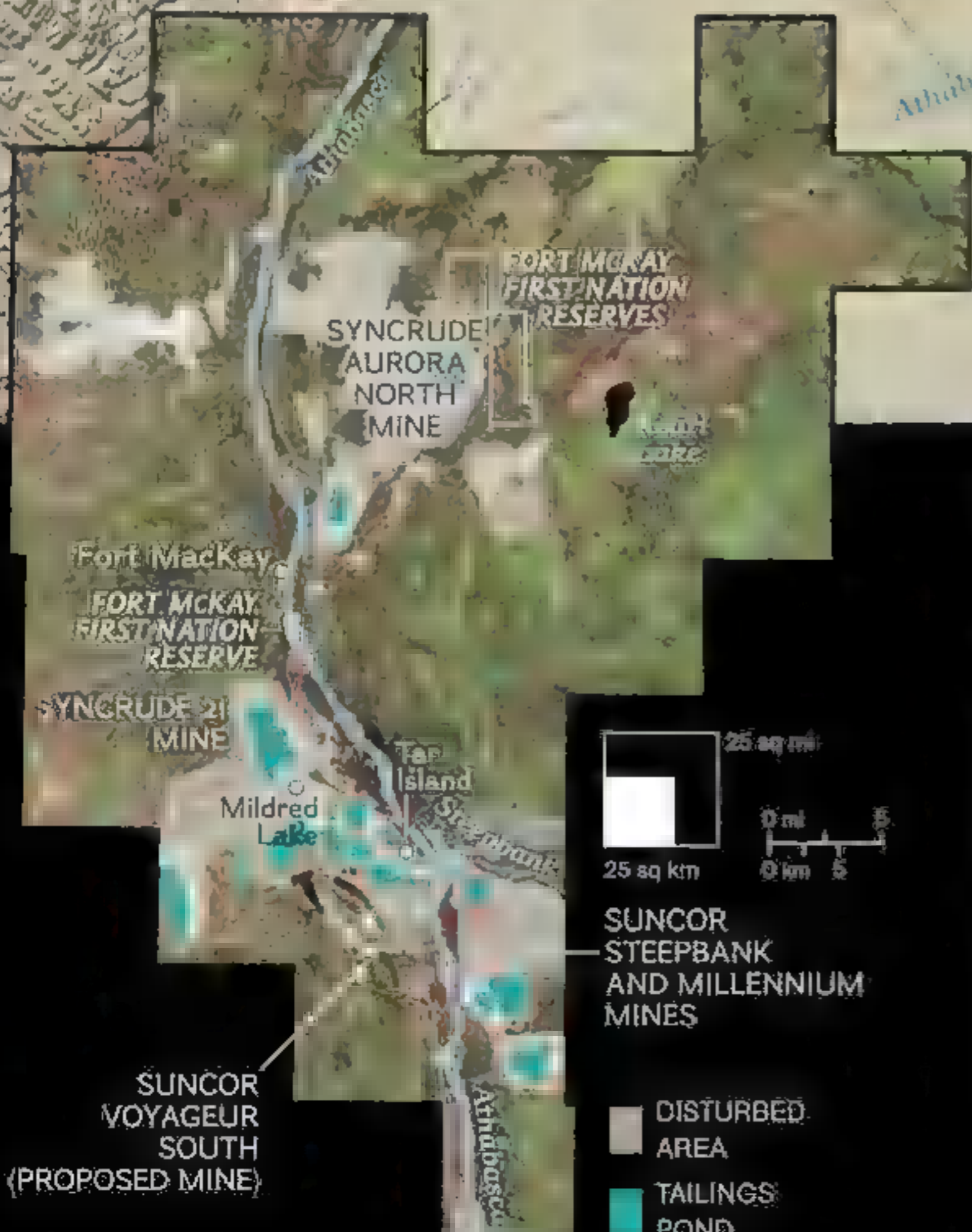
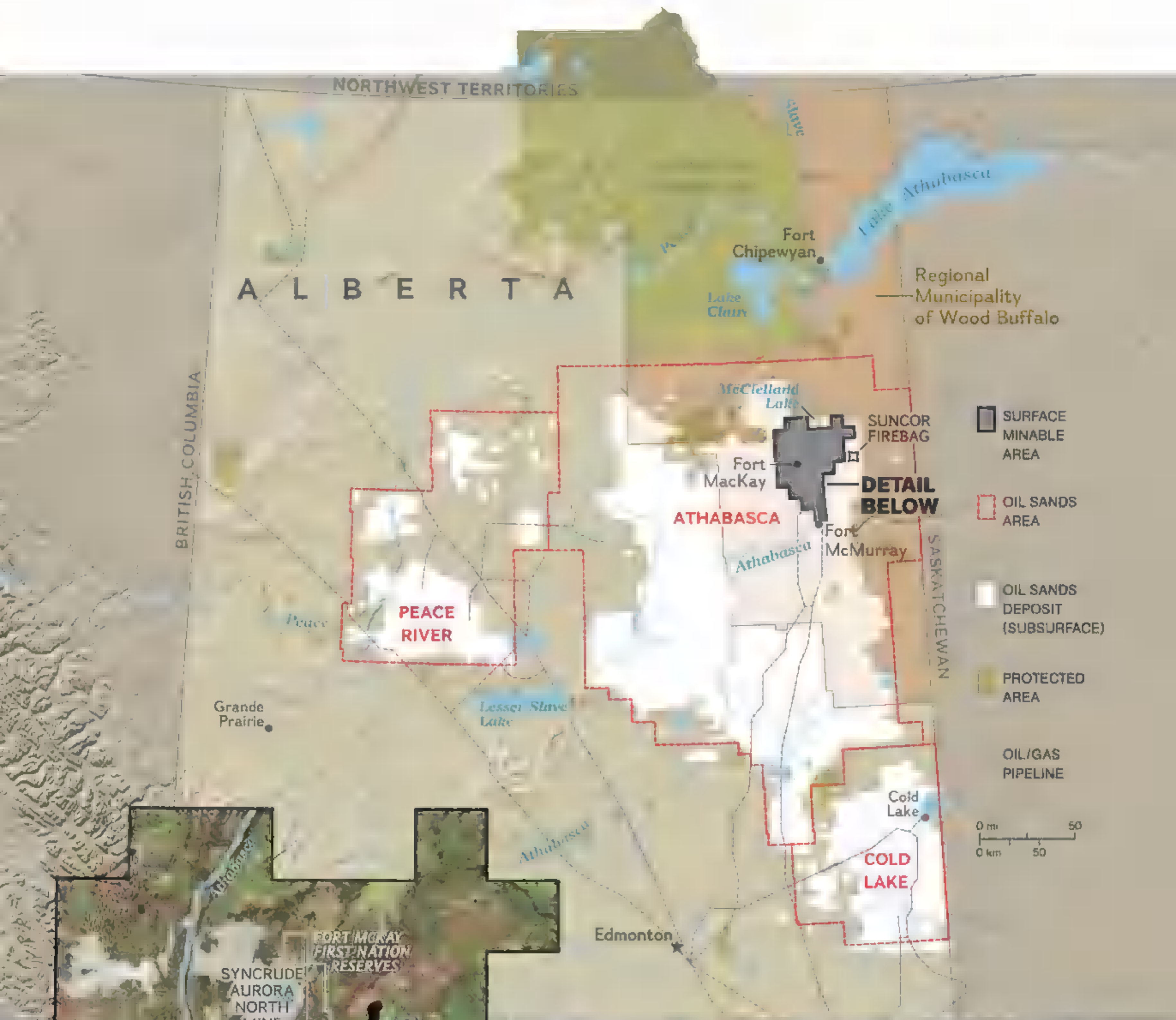
The U.S. imports more oil from Canada than from any other nation, about 19 percent of its total foreign supply, and around half of that now comes from the oil sands. Anything that reduces our dependence on Middle Eastern oil, many Americans would say, is a good thing. But clawing and cooking a barrel of crude from the oil sands emits as much as three times more carbon dioxide than letting one gush from the ground in Saudi Arabia. The oil sands are still a tiny part of the world’s carbon problem—they account for less than a tenth of one percent of global CO₂ emissions—but to many environmentalists they are the thin end of the wedge, the first

step along a path that could lead to other, even dirtier sources of oil: producing it from oil shale or coal. “Oil sands represent a decision point for North America and the world,” says Simon Dyer of the Pembina Institute, a moderate and widely respected Canadian environmental group. “Are we going to get serious about alternative energy, or are we going to go down the unconventional-oil track? The fact that we’re willing to move four tons of earth for a single barrel really shows that the world is running out of easy oil.”

That thirsty world has come crashing in on Fort McKay. Yet Jim Boucher’s view of it, from an elegant new building at the entrance to the besieged little village, contains more shades of gray than you might expect. “The choice we make is a difficult one,” Boucher said when I visited him last summer. For a long time the First Nation tried to fight the oil sands industry, with little success. Now, Boucher said, “we’re trying to develop the community’s capacity to take advantage of the opportunity.” Boucher presides not only over this First Nation, as chief, but also over the Fort McKay Group of Companies, a community-owned business that provides services to the oil sands industry and brought in \$85 million in 2007. Unemployment is under 5 percent in the village, and it has a health clinic, a youth center, and a hundred new three-bedroom houses that the community rents to its members for far less than market rates. The First Nation is even thinking of opening its own mine: It owns 8,200 acres of prime oil sands land across the river, right next to the Syncrude mine where the ducks died.

As Boucher was telling me all this, he was picking bits of meat from a smoked whitefish splayed out on his conference table next to a bank of windows that offered a panoramic view of the river. A staff member had delivered the fish in a plastic bag, but Boucher couldn’t say where it had come from. “I can tell you one thing,” he said. “It doesn’t come from the Athabasca.”

WITHOUT THE RIVER, there would be no oil sands industry. It’s the river that over tens of millions of years has eroded away billions

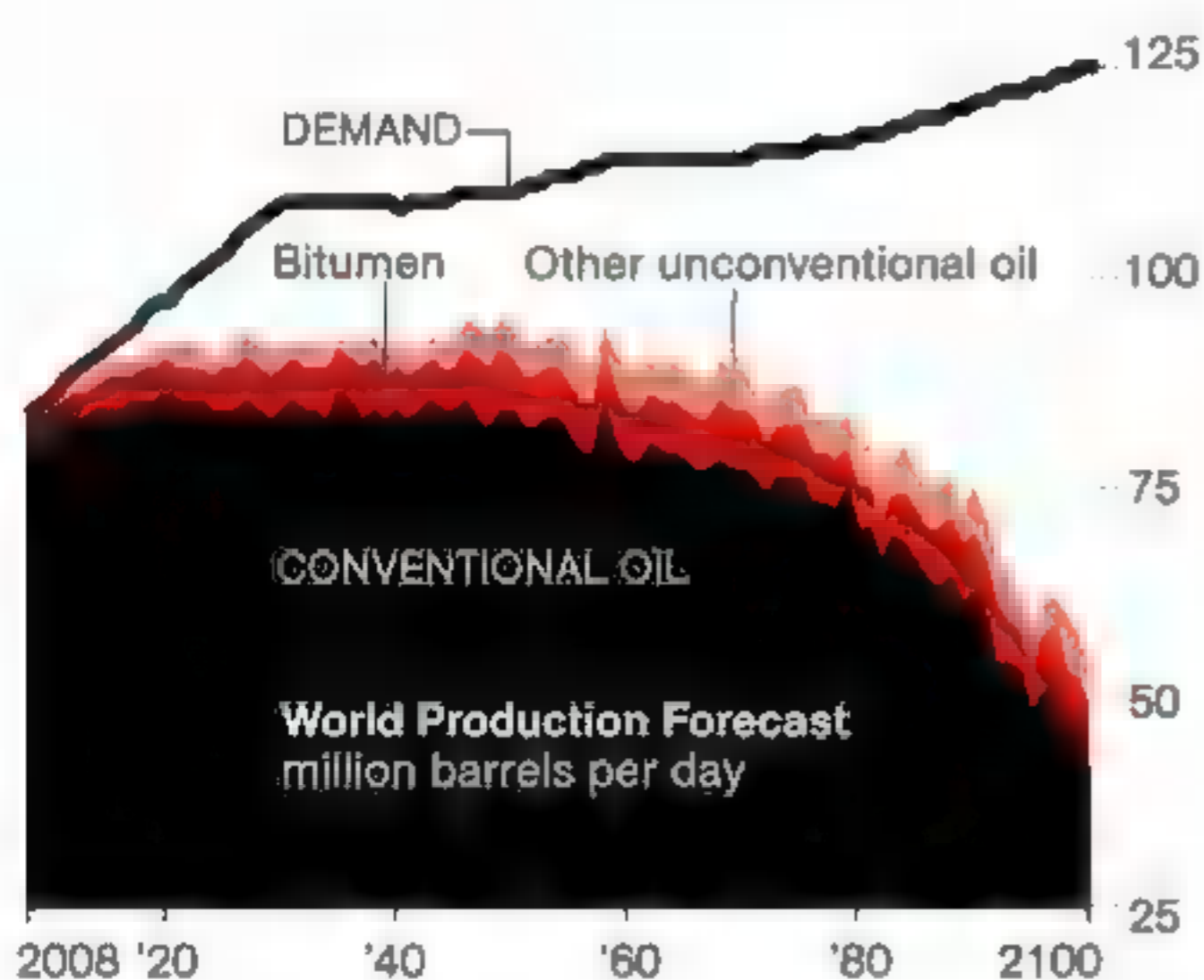


Alberta's oil sands place Canada second only to Saudi Arabia in proven oil reserves. The sands are extracted from surface mines in a 1,356-square-mile fragment of the vast Athabasca deposit (satellite image, left) where they lie less than 200 feet deep. In other areas, bitumen is tapped using the "in situ" method. By 2020, production may triple to more than two million barrels a day.

MARTIN GAMACHE, NG STAFF. SOURCES: ALBERTA GEOLOGICAL SURVEY; ALTALIS; TIM MARKLE, ALBERTA DEPARTMENT OF ENERGY; PLATTS. INSET IMAGE: 2006, LANDSAT.ORG. DISTURBED AREAS: 2008, SPOT IMAGE.

“The fact that we’re willing to move four tons of earth for a single barrel really shows that the world is running out of easy oil.”

—SIMON DYER, PEMBINA INSTITUTE



Within the next few decades, production of conventional oil around the world is projected to level off, then decline, even as demand continues to grow. Production from unconventional sources such as oil sands are also expected to drop if governments impose constraints to protect the environment.

of cubic yards of sediment that once covered the bitumen, thereby bringing it within reach of shovels—and in some places all the way to the surface. On a hot summer day along the Athabasca, near Fort McKay for example, bitumen oozes from the riverbank and casts an oily sheen on the water. Early fur traders reported seeing the stuff and watching natives use it to caulk their canoes. At room temperature, bitumen is like molasses, and below 50°F or so it is hard as a hockey puck, as Canadians invariably put it. Once upon a time, though, it was light crude, the same liquid that oil companies have been pumping from deep traps in southern Alberta for nearly a century. Tens of millions of years ago, geologists think, a large volume of that oil was pushed northeastward, perhaps by the rise of the Rocky Mountains. In the process it also migrated upward, along sloping layers of sediment, until eventually it reached depths shallow and cool enough for bacteria to thrive. Those bacteria degraded the oil to bitumen.

The Alberta government estimates that the province’s three main oil sands deposits, of which the Athabasca one is the largest, contain 173 billion barrels of oil that are economically recoverable today. “The size of that, on the world stage—it’s massive,” says Rick George, CEO of Suncor, which opened the first mine on the Athabasca River in 1967. In 2003, when the *Oil & Gas Journal* added the Alberta oil sands to its list of proven reserves, it immediately propelled Canada to second place, behind Saudi Arabia, among oil-producing nations. The proven reserves in the oil sands are eight times those of the entire U.S. “And that number will do nothing but go up,” says George. The Alberta Energy Resources and Conservation Board estimates that more than 300 billion barrels may one day be recoverable from the oil sands; it puts the total size of the deposit at 1.7 trillion barrels.

Getting oil from oil sands is simple but not easy. The giant electric shovels that rule the

Robert Kunzig wrote about drought in the West in February 2008. Peter Essick’s most recent assignment was photographing the Ozark Highlands Trail.

Black Gold Too Deep to Mine

About 80 percent of the bitumen potentially recoverable from Canada's oil sands is in deposits deeper than 200 feet, requiring more energy to extract than bitumen from surface mines. Injecting steam into wells and upgrading the bitumen consumes vast amounts of water and natural gas.

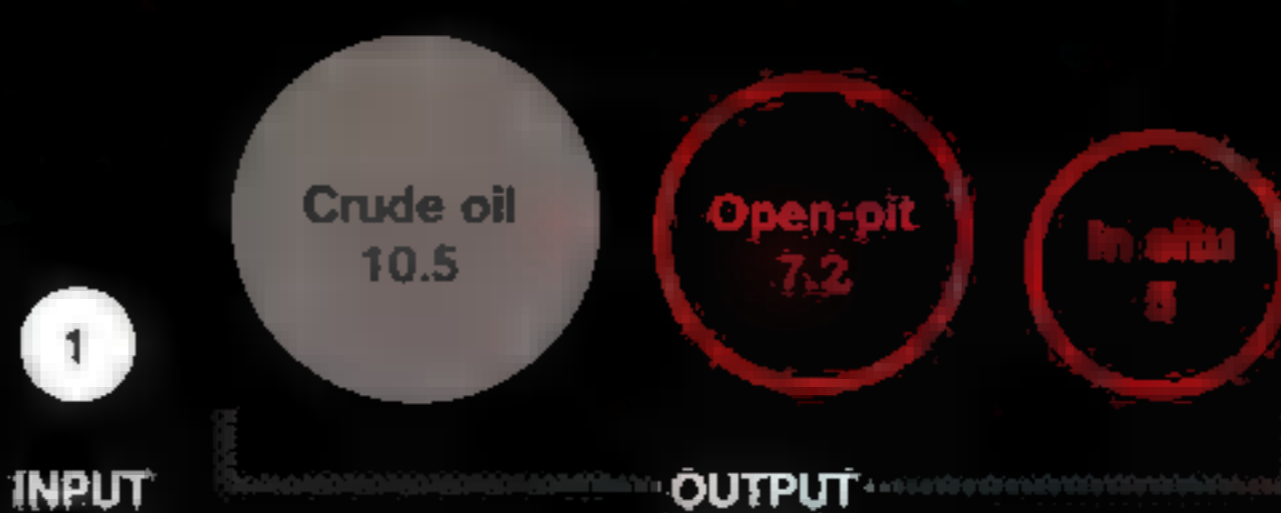


Oil sands production uses enough natural gas daily to heat more than **3 million** homes.

To extract oil in situ, energy companies sink pairs of wells as deep as 1,500 feet, then drill horizontally into oil sands. One well is placed above the other. The top well (1) injects steam to melt the bitumen. Gravity causes the fluid to flow toward the lower recovery well (2), which pumps liquefied bitumen to the surface.



Oil tapped from the oil sands by in situ facilities delivers only **half as much energy** as conventional crude for each unit of energy used to extract and produce.



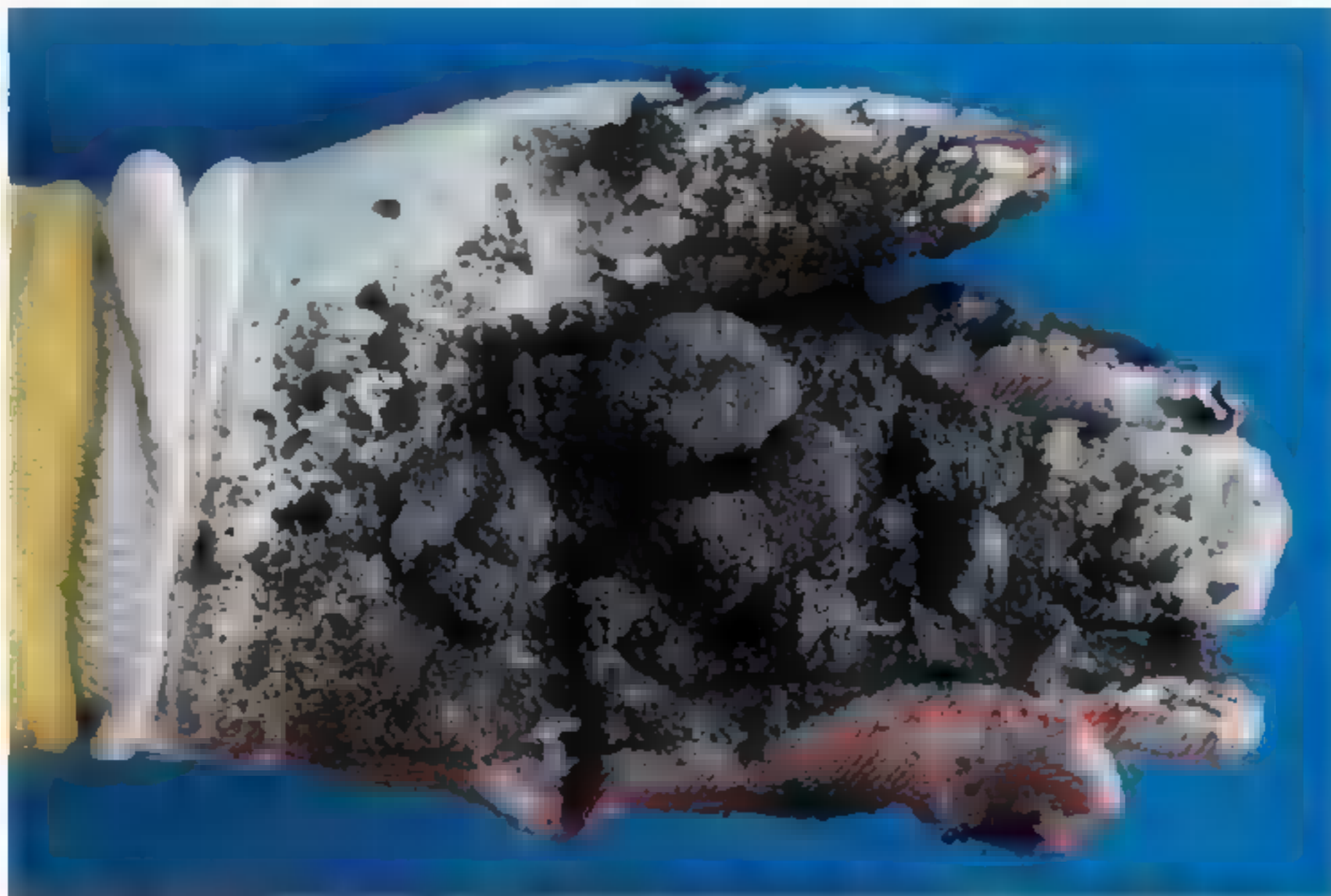
Bitumen extraction and upgrading emits up to **3 times** more CO₂ per barrel than conventional oil.

In situ extraction.....
Up to 388 lbs.

Open-pit mining.....
Up to 364 lbs.

Crude oil.....
Up to 128 lbs.

CO₂ EMISSIONS PER BARREL



A fistful of oil sand contains just 10 to 15 percent bitumen. Only in the past decade have technology and demand merged to make this complex industry profitable. About half the oil produced heads south: The U.S. is Canada's biggest oil customer, importing more from its northern neighbor than from any other nation.

mines have hardened steel teeth that each weigh a ton, and as those teeth claw into the abrasive black sand 24/7, 365 days a year, they wear down every day or two; a welder then plays dentist to the dinosaurs, giving them new crowns. The dump trucks that rumble around the mine, hauling 400-ton loads from the shovels to a rock crusher, burn 50 gallons of diesel fuel an hour; it takes a forklift to change their tires, which wear out in six months. And every day in the Athabasca Valley, more than a million tons of sand emerges from such crushers and is mixed with more than 200,000 tons of water that must be heated, typically to 175°F, to wash out the gluey bitumen. At the upgraders, the bitumen gets heated again, to about 900°F, and compressed to more than 100 atmospheres—that's what it takes to crack the complex molecules and either subtract carbon or add back the hydrogen the bacteria removed ages ago. That's what it takes to make the light hydrocarbons we need to fill our gas tanks. It takes a stupendous amount of energy. In situ extraction, which is the only way to get at around 80 percent of those 173 billion barrels, can use up to twice as much energy as mining, because it requires so much steam.

Most of the energy to heat the water or make steam comes from burning natural gas, which also supplies the hydrogen for upgrading. Precisely because it is hydrogen rich and mostly free of impurities, natural gas is the cleanest

burning fossil fuel, the one that puts the least amount of carbon and other pollutants into the atmosphere. Critics thus say the oil sands industry is wasting the cleanest fuel to make the dirtiest—that it turns gold into lead. The argument makes environmental but not economic sense, says David Keith, a physicist and energy expert at the University of Calgary. Each barrel of synthetic crude contains about five times more energy than the natural gas used to make it, and in much more valuable liquid form. "In economic terms it's a slam dunk," says Keith. "This whole thing about turning gold into lead—it's the other way around. The gold in our society is liquid transportation fuels."

Most of the carbon emissions from such fuels comes from the tailpipes of the cars that burn them; on a "wells-to-wheels" basis, the oil sands are only 15 to 40 percent dirtier than conventional oil. But the heavier carbon footprint remains an environmental—and public relations—disadvantage. Last June Alberta's premier, Ed Stelmach, announced a plan to deal with the extra emissions. The province, he said, will spend over \$1.5 billion to develop the technology for capturing carbon dioxide and storing it underground—a strategy touted for years as a solution to climate change. By 2015 Alberta is hoping to capture five million tons of CO₂ a year from bitumen upgraders as well as from coal-fired power plants, which even in Alberta,

to say nothing of the rest of the world, are a far larger source of CO₂ than the oil sands. By 2020, according to the plan, the province's carbon emissions will level off, and by 2050 they will decline to 15 percent below their 2005 levels. That is far less of a cut than scientists say is necessary. But it is more than the U.S. government, say, has committed to in a credible way.

One thing Stelmach has consistently refused to do is “touch the brake” on the oil sands boom. The boom has been gold for the provincial as well as the national economy; the town of Fort McMurray, south of the mines, is awash in Newfoundlanders and Nova Scotians fleeing unemployment in their own provinces. The provincial government has been collecting around a third of its revenue from lease sales and royalties on fossil fuel extraction, including oil sands—it was expecting to get nearly half this year, or \$19 billion, but the collapse in oil prices since the summer has dropped that estimate to about \$12 billion. Albertans are bitterly familiar with the boom-and-bust cycle; the last time oil prices collapsed, in the 1980s, the provincial economy didn't recover for a decade. The oil sands cover an area the size of North Carolina, and the provincial government has already leased around half that, including all 1,356 square miles that are minable. It has yet to turn down an application to develop one of those leases, on environmental or any other grounds.

FROM A HELICOPTER it's easy to see the industry's impact on the Athabasca Valley. Within minutes of lifting off from Fort McMurray, heading north along the east bank of the river, you pass over Suncor's Millennium mine—the company's leases extend practically to the town. On a day with a bit of wind, dust plumes billowing off the wheels and the loads of the dump trucks coalesce into a single enormous cloud that obscures large parts of the mine pit and spills over its lip. To the north, beyond a small expanse of intact forest, a similar cloud rises from the next pit, Suncor's Steepbank mine, and beyond that lie two more, and across the river two more. One evening last July the clouds

The oil sands are gold not only for the oil companies, but also for Alberta's provincial government, which owns the mineral rights to virtually all the land and has encouraged the industry for three-quarters of a century.



PORTRAITS OF A BOOMTOWN Drivers pack Thickwood Boulevard in Fort McMurray during the morning commute (above). The oil boom has lured thousands here, from unemployed fishermen from eastern provinces to immigrant nannies longing for Canadian citizenship, and spawned a building explosion. A worker tamps sod in a new development (below) while more streets are laid nearby for





mobile-home neighborhoods (above). The average single-family house costs about \$540,000, steep even in a region where wages regularly top \$80,000 a year. But prosperity eludes many, including Janice "Jazzy" Desjarlais (below, left) and Cameron McGillvery, who struggle with Alberta's increasingly common challenges of high living costs, unemployment, and homelessness.



"It's my little genie bottle," says Kellyanne Forster of her tiny room at the Salina Creek Camp. Forster moved from Saskatchewan to drive "the biggest trucks in the world" for good money, and she doesn't mind cramped living conditions. "Women make better drivers than men," she jokes. "I'm the most reasonable. We treat the customers better."





SIZE MATTER



one of the...



Ronnie Campbell hauls whitefish from Lake Athabasca, downriver from Fort McMurray, to use as feed for his sled dogs. Locals say their catches are often covered in unusual red spots, and many no longer eat lake fish. While the cause of the spots is unclear, some believe toxic chemicals, such as those released during bitumen production, are leaching into Alberta's rivers and lakes.

had merged into a band of dust sweeping west across the devastated landscape. It was being sucked into the updraft of a storm cloud. In the distance steam and smoke and gas flames belched from the stacks of the Syncrude and Suncor upgraders—"dark satanic mills" inevitably come to mind, but they're a riveting sight all the same. From many miles away, you could smell the tarry stench. It stings your lungs when you get close enough.

From the air, however, the mines fall away quickly. Skimming low over the river, startling a young moose that was fording a narrow channel, a government biologist named Preston McEachern and I veered northwest toward the Birch Mountains, over vast expanses of scarcely disturbed forest. The Canadian boreal forest covers two million square miles, of which around 75 percent remains undeveloped. The oil sands mines have so far converted over 150 square miles—a hundredth of a percent of the total area—into dust, dirt, and tailings ponds. Expansion of in situ extraction could affect a much larger area. At Suncor's Firebag facility, northeast of the Millennium mine, the forest has not been razed, but it has been dissected by roads and pipelines that service a checkerboard of large clearings, in each of which Suncor extracts deeply buried bitumen through a cluster of wells. Environmentalists and wildlife biologists worry that the widening fragmentation of the

forest, by timber as well as mineral companies, endangers the woodland caribou and other animals. "The boreal forest as we know it could be gone in a generation without major policy changes," says Steve Kallick, director of the Pew Boreal Campaign, which aims to protect 50 percent of the forest.

McEachern, who works for Alberta Environment, a provincial agency, says the tailings ponds are his top concern. The mines dump wastewater in the ponds, he explains, because they are not allowed to dump waste into the Athabasca, and because they need to reuse the water. As the thick, brown slurry gushes from the discharge pipes, the sand quickly settles out, building the dike that retains the pond; the residual bitumen floats to the top. The fine clay and silt particles, though, take several years to settle, and when they do, they produce a yogurt-like goop—the technical term is "mature fine tailings"—that is contaminated with toxic chemicals such as naphthenic acid and polycyclic aromatic hydrocarbons (PAH) and would take centuries to dry out on its own. Under the terms of their licenses, the mines are required to reclaim it somehow, but they have been missing their deadlines and still have not fully reclaimed ■ single pond.

In the oldest and most notorious one, Suncor's Pond 1, the sludge is perched high above the river, held back by a dike of compacted sand that rises more than 300 feet from the valley

floor and is studded with pine trees. The dike has leaked in the past, and in 2007 a modeling study done by hydrogeologists at the University of Waterloo estimated that 45,000 gallons a day of contaminated water could be reaching the river. Suncor is now in the process of reclaiming Pond 1, piping some tailings to another pond, and replacing them with gypsum to consolidate the tailings. By 2010, the company says, the surface will be solid enough to plant trees on. Last summer it was still a blot of beige mud streaked with black bitumen and dotted with orange plastic scarecrows that are supposed to dissuade birds from landing and killing themselves.

THE ALBERTA GOVERNMENT asserts that the river is not being contaminated—that anything found in the river or in its delta, at Lake Athabasca, comes from natural bitumen seeps. The river cuts right through the oil sands downstream of the mines, and as our chopper zoomed along a few feet above it, McEachern pointed out several places where the riverbank was black and the water oily. “There is an increase in a lot of metals as you move downstream,” he said. “That’s natural—it’s weathering of the geology. There’s mercury in the fish up at Lake Athabasca—we’ve had an advisory there since the 1990s. There are PAHs in the sediments in the delta. They’re there because the river has eroded through the oil sands.”

Independent scientists, to say nothing of people who live downstream of the mines in the First Nations’ community of Fort Chipewyan, on Lake Athabasca, are skeptical. “It’s inconceivable that you could move that much tar and have no effect,” says Peter Hodson, a fish toxicologist at Queen’s University in Ontario. An Environment Canada study did in fact show an effect on fish in the Steepbank River, which flows past a Suncor mine into the Athabasca. Fish near the mine, Gerald Tetreault and his colleagues found when they caught some in 1999 and 2000, showed five times more activity of a liver enzyme that breaks down toxins—a widely used measure of exposure to pollutants—as did fish near a natural bitumen seep on the Steepbank.

“The thing that angers me,” says David

**In the distance
steam and smoke
and gas flames
belched from the
stacks of the Syn-
crude and Suncor
upgraders—“dark
satanic mills”
inevitably come to
mind, but they’re
a riveting sight
all the same.**





On the banks of the Athabasca River, Suncor's upgrader plants refined an average of 235,000 barrels of petroleum products a day in 2008. A narrow dike separates the river from ponds that hold water used during the industrial process, which will be cleaned before being reused.

Schindler, “is that there’s been no concerted effort to find out where the truth lies.”

Schindler, an ecologist at the University of Alberta in Edmonton, was talking about whether people in Fort Chipewyan have already been killed by pollution from the oil sands. In 2006 John O’Connor, a family physician who flew in weekly to treat patients at the health clinic in Fort Chip, told a radio interviewer that he had in recent years seen five cases of cholangiocarcinoma—a cancer of the bile duct that normally strikes one in 100,000 people. Fort Chip has a population of around 1,000; statistically it was unlikely to have even one case. O’Connor hadn’t managed to interest health authorities in the cancer cluster, but the radio interview drew wide attention to the story. “Suddenly it was everywhere,” he says. “It just exploded.”

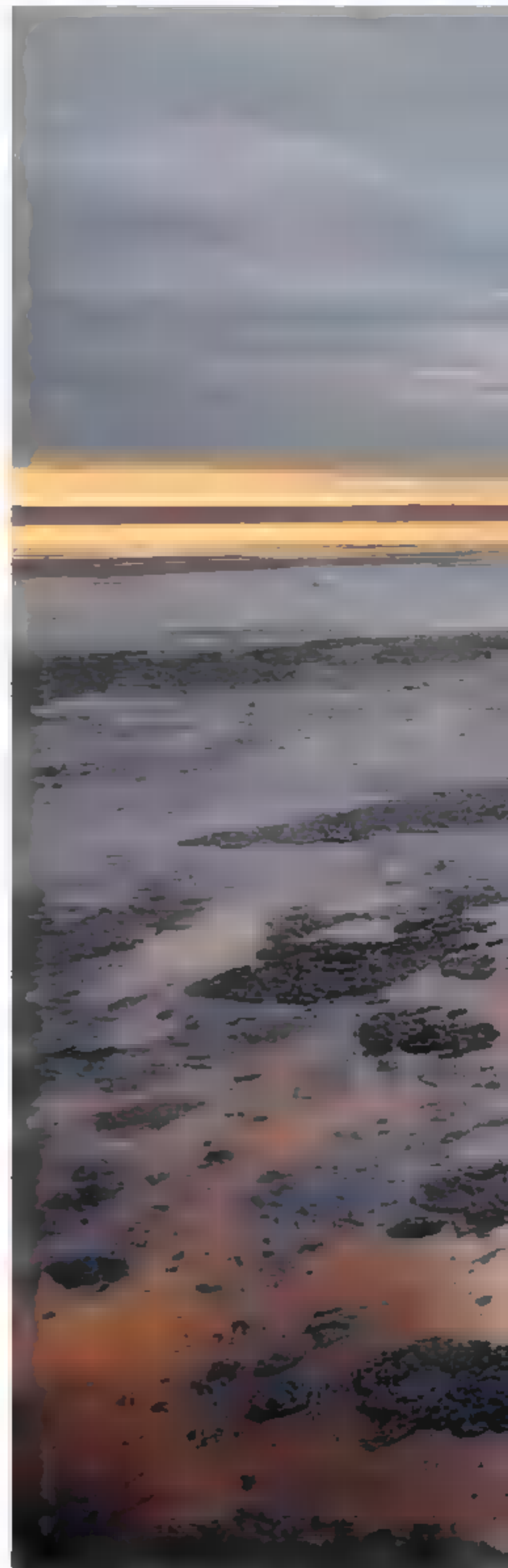
Two of O’Connor’s five cases, he says, had been confirmed by tissue biopsy; the other three patients had shown the same symptoms but had died before they could be biopsied. (Cholangiocarcinoma can be confused on CT scans with more common cancers such as liver or pancreatic cancer.) “There is no evidence of elevated cancer rates in the community,” Howard May, a spokesperson for Alberta Health, wrote in an email last September. But the agency, he said, was nonetheless conducting a more complete investigation—this time actually examining the medical records from Fort Chip—to try to quiet a controversy that was now two years old.

ONE WINTER NIGHT when Jim Boucher was a young boy, around the time the oil sands industry came to his forest, he was returning alone by dogsled to his grandparents’ cabin from an errand in Fort McKay. It was a journey of 20 miles or so, and the temperature was minus 4°F. In the moonlight Boucher spotted a flock of ptarmigan, white birds in the snow. He killed around 50, loaded them on the dogsled, and brought them home. Four decades later, sitting in his chief-executive office in white chinos and a white Adidas sport shirt, he remembers the pride on his grandmother’s face that night. “That was a different spiritual world,” Boucher

Floating among mats of leftover bitumen on a thousand-acre tailings pond, a radar device scans for incoming birds. The fake falcon flaps its wings, and predator calls blare to scare off waterfowl that would die if they landed on the surface and their feathers became soaked with sludge.

says. “I saw that world continuing forever.” He tells the story now when asked about the future of the oil sands and his people’s place in it.

A poll conducted by the Pembina Institute in 2007 found that 71 percent of Albertans favored an idea their government has always rejected out of hand: a moratorium on new oil sands projects until environmental concerns can be resolved. “It’s my belief that when government attempts to manipulate the free market, bad things





happen,” Premier Stelmach told a gathering of oil industry executives that year. “The free-market system will solve this.”

But the free market does not consider the effects of the mines on the river or the forest, or on the people who live there, unless it is forced to. Nor, left to itself, will it consider the effects of the oil sands on climate. Jim Boucher has collaborated with the oil sands industry in order to build a new economy for his people,

to replace the one they lost, to provide a new future for kids who no longer hunt ptarmigan in the moonlight. But he is aware of the trade-offs. “It’s a struggle to balance the needs of today and tomorrow when you look at the environment we’re going to live in,” he says. In northern Alberta the question of how to strike that balance has been left to the free market, and its answer has been to forget about tomorrow. Tomorrow is not its job. □

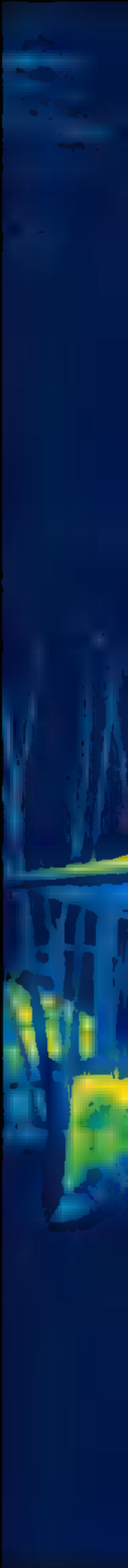
SAVING ENERGY

IT STARTS AT HOME

We already know the fastest, least expensive way to slow climate change: Use less energy. With a little effort, and not much money, most of us could reduce our energy diets by 25 percent or more—doing the Earth a favor while also helping our pocketbooks. So what's holding us back?

Thermographic photography offers clues to where energy is being wasted in this older house in Connecticut. Red and yellow patches indicate escaping heat, while new double-pane windows appear cool blue. By sealing in warmth, the windows cut heating costs, which can account for up to half a family's energy bill.

BY PETER MILLER PHOTOGRAPHS BY TYRONE TURNER



321 | MICROWAVE: **179** | DISHWASHER: **599** | REFRIGERATOR: **1,191** | CENTRAL AC: **4,067** | TOASTER: **53**

Pounds of CO₂ emitted
per item each year in the U.S.





Not long ago, my wife, PJ, and I tried a new diet—not to lose a little weight but to answer a nagging question about climate change. Scientists have reported recently that the world is heating up even faster than predicted only a few years ago, and that the consequences could be severe if we don't keep reducing emissions of carbon dioxide and other greenhouse gases that are trapping heat in our atmosphere. But what can we do about it as individuals? And as emissions from China, India, and other developing nations skyrocket, **will our efforts really make any difference?**



We decided to try an experiment. For one month we tracked our personal emissions of carbon dioxide (CO₂) as if we were counting calories. We wanted to see how much we could cut back, so we put ourselves on a strict diet. The average U.S. household produces about 150 pounds of CO₂ a day by doing commonplace things like turning on air-conditioning or driving cars. That's more than twice the European average and almost five times the global average, mostly because Americans drive more and have bigger houses. But how much should we try to reduce?

For an answer, I checked with Tim Flannery, author of *The Weather Makers: How Man Is Changing the Climate and What It Means for*

"We're farm people," says Janice Haney of Greensburg, Kansas. "I enjoy hanging clothes out. We don't have to waste electricity on the dryer. The good old Kansas wind can do it on its own."

Life on Earth. In his book, he'd challenged readers to make deep cuts in personal emissions to keep the world from reaching critical tipping points, such as the melting of the ice sheets in Greenland or West Antarctica. "To stay below that threshold, we need to reduce CO₂ emissions by 80 percent," he said.

"That sounds like a lot," PJ said. "Can we really do that?"

It seemed unlikely to me too. Still, the point was to answer a simple question: How close

GAS FURNACE: **6,967** | ONE CAR: **11,903** | CEILING FAN: **115** | SHAVER: **1** | RECHARGEABLE TOOTHBRUSH:



THE MISSING POWER PLANT

Instead of building a new 730-megawatt facility like the Decker Power Plant, the Austin, Texas, electric utility reduced demand by the same amount through rebates on energy-saving appliances and other programs. "Go into any store in Austin, and you can't buy an inefficient air conditioner," says general manager Roger Duncan (above). "They just stopped stocking them."



could we come to a lifestyle the planet could handle? If it turned out we couldn't do it, perhaps we could at least identify places where the diet pinched and figure out ways to adjust. So we agreed to shoot for 80 percent less than the U.S. average, which equated to a daily diet of only 30 pounds of CO₂. Then we set out to find ■ few neighbors to join us.

John and Kyoko Bauer were logical candidates. Dedicated greenies, they were already committed to a low-impact lifestyle. One car, one TV, no meat except fish. As parents of three-year-old twins, they were also worried about the future. "Absolutely, sign us up," John said.

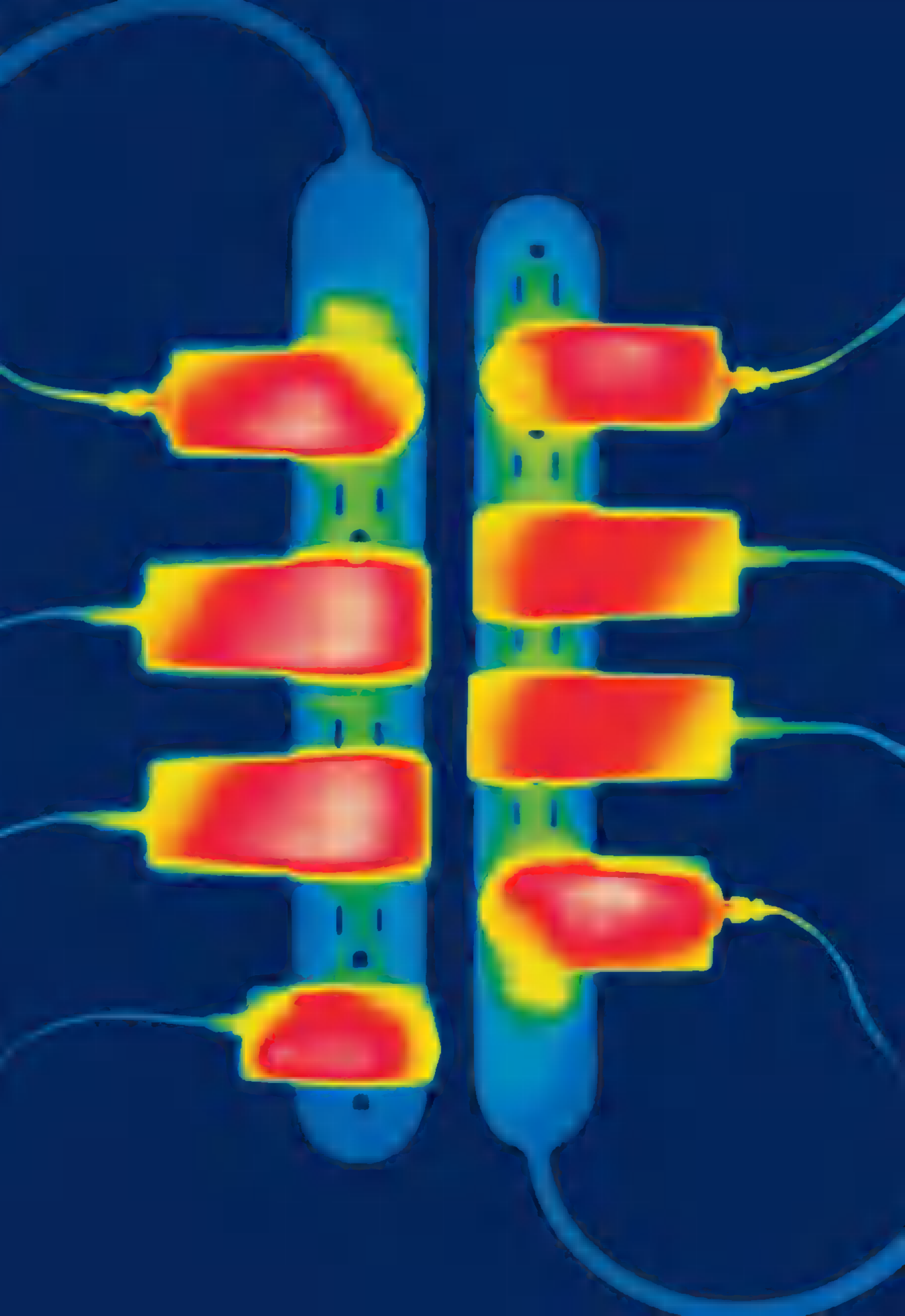
Susan and Mitch Freedman, meanwhile, had two teenagers. Susan wasn't sure how eager they would be to cut back during their summer vacation, but she was game to give the diet a try. As an architect, Mitch was working on an office building designed to be energy efficient, so he was curious how much they could save at home. So the Freedmans were in too.

WE STARTED ON A SUNDAY in July, an unseasonably mild day in Northern Virginia, where we live. A front had blown through the night before, and I'd opened our bedroom windows to let in the breeze. We'd gotten so used to keeping our air-conditioning going around the clock, I'd almost forgotten the windows even opened. The birds woke us at five with a pleasant racket in the trees, the sun came up, and our experiment began.

Our first challenge was to find ways to convert our daily activities into pounds of CO₂. We wanted to track our progress as we went, to change our habits if necessary.

PJ volunteered to read our electric meter each morning and to check the odometer on our Mazda Miata. While she was doing that, I wrote down the mileage from our Honda CR-V and pushed my way through the shrubs to read the natural gas meter. We diligently recorded

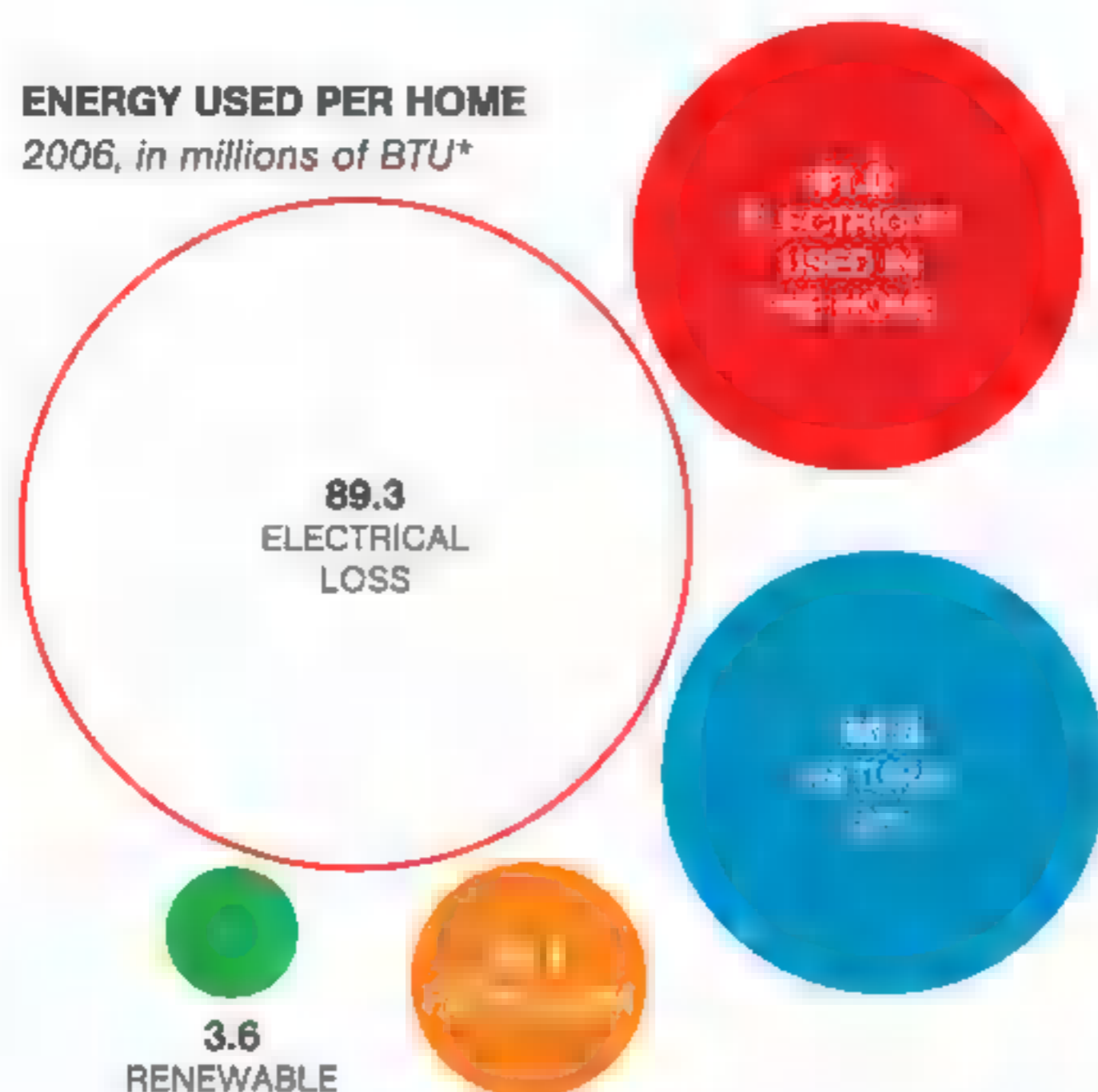
Peter Miller is a senior editor at National Geographic. Photographer Tyrone Turner's last feature for the magazine was on New Orleans after Katrina.



THE POWERED HOUSE

Electricity is the biggest source of power for U.S. homes—and for every kilowatt-hour used, 2.2 are “lost” as that energy is generated and sent over transmission lines. So, even small changes in our habits can scale up to big reductions in carbon emissions.

ENERGY USED PER HOME
2006, in millions of BTU*



If we converted half of all light-bulbs to compact fluorescents, we would reduce CO₂ from lighting by 42.4 million tons a year, or 36 percent.

If we turned off home computers when not in use, we would cut their CO₂ impact by 8.3 million tons a year, or 50 percent.

CO₂ AMOUNTS MEASURED IN METRIC TONS

*THE BRITISH THERMAL UNIT (BTU) IS USED TO MEASURE THE ENERGY CONTENT OF FUELS AND THE POWER OF HEATING AND COOLING SYSTEMS. ONE KILOWATT-HOUR OF ELECTRICITY IS EQUIVALENT TO 3,412 BTU.

SEAN MCNAUGHTON, NG STAFF

SOURCE: ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2008

Left: The red glow of warm adapter plugs shows they keep using power even when the appliances they're connected to are turned off—as much in a year, in some cases, as the appliances themselves.

everything on a chart taped to one of our kitchen cabinets. A gallon of gasoline, we learned, adds a whopping 19.6 pounds of CO₂ to the atmosphere, a big chunk of our daily allowance. A kilowatt-hour (kWh) of electricity in the U.S. produces 1.5 pounds of CO₂. Every 100 cubic feet of natural gas emits 12 pounds of CO₂.

To get a rough idea of our current carbon footprint, I plugged numbers from recent utility bills into several calculators on websites. Each asked for slightly different information, and each came up with a different result. None was flattering. The Environmental Protection Agency (EPA) website figured our annual CO₂ emissions at 54,273 pounds, 30 percent higher than the average American family with two people; the main culprit was the energy we were using to heat and cool our house. Evidently, we had further to go than I thought.

I began our campaign by grabbing a flashlight and heading down to the basement. For most families, the water heater alone consumes 12 percent of their house's energy. My plan was to turn down the heater's thermostat to 120°F, as experts recommend. But taking a close look at our tank, I saw only “hot” and “warm” settings, no degrees. Not knowing what that meant exactly, I twisted the dial to warm and hoped for the best. (The water turned out to be a little cool, and I had to adjust it later.)

When PJ drove off in the CR-V to pick up a friend for church, I hauled out gear to cut the grass: electric lawn mower, electric edger, electric leaf blower. Then it dawned on me: All this power-sucking equipment was going to cost us in CO₂ emissions. So I stuffed everything back into the garage, hopped in the Miata, and buzzed down the street to Home Depot to price out an old-fashioned push reel mower.

The store didn't have one, so I drove a few miles more to Lawn & Leisure, an outfit that specializes in lawn mowers. They were out too, though they had plenty of big riding mowers on display. (The average gasoline-powered push mower, I'd learned, puts out as much pollution per hour as eleven cars—a riding mower as much as 34 cars.) My next stop was Wal-Mart,

where I found another empty spot on the rack. I finally tried Sears, which had one manual mower left, the display model.

I'd seen advertisements for the latest reel mowers that made them sound like precision instruments, not the clunky beast I pushed as a teenager. But when I gave the display model a spin across the sales floor, I was disappointed. The reel felt clumsy compared with my corded electric model, which I can easily maneuver with one hand. I got back in the car empty-handed and drove home.

As I pulled into the driveway, I had the sinking realization I'd been off on a fool's errand. I didn't know exactly how foolish until the next morning, when we added up the numbers. I'd driven 24 miles in search of a more Earth-friendly mower. PJ had driven 27 miles to visit a friend in an assisted-living facility. We'd used 32 kWh of electricity and 100 cubic feet of gas to cook dinner and dry our clothes. Our total CO₂ emissions for the day: 105.6 pounds. Three and a half times our target.

"Guess we need to try harder," PJ said.

WE GOT SOME HELP IN WEEK TWO from a professional "house doctor," Ed Minch, of Energy Services Group in Wilmington, Delaware. We asked Minch to do an energy audit of our house to see if we'd missed any easy fixes. The first thing he did was walk around the outside of the house, looking at how the "envelope" was put together. Had the architect and builder created any opportunities for air to seep in or out, such as overhanging floors? Next he went inside and used an infrared scanner to look at our interior walls. A hot or cold spot might mean that we had a duct problem or that insulation in a wall wasn't doing its job. Finally his assistants set up a powerful fan in our front door to lower air pressure inside the house and force air through whatever leaks there might be in the shell of the house. Our house, his instruments showed, was 50 percent leakier than it should be.

One reason, Minch discovered, was that our builder had left a narrow, rectangular hole in our foundation beneath the laundry room—for

what reason we could only guess. Leaves from our yard had blown through the hole into the crawl space. "There's your big hit," he said. "That's your open window." I hadn't looked inside the crawl space in years, so there could have been a family of monkeys under there for all I knew. Sealing up that hole was now a priority, since heating represents up to half of a house's energy costs, and cooling can account for a tenth.

Air rushing in through the foundation was only part of the problem, however. Much of the rest was air seeping out of a closet on our second floor, where a small furnace unit was located. The closet had never been completely drywalled, so air filtered through insulation in the roof to the great outdoors. Minch recommended we finish the drywalling when the time comes to replace the furnace.

Minch also gave us tips about lighting and appliances. "A typical kitchen these days has ten 75-watt spots on all day," he said. "That's a huge waste of money." Replacing them with compact fluorescents could save a homeowner \$200 a year. Refrigerators, washing machines, dishwashers, and other appliances, in fact, may represent half of a household's electric bill. Those with Energy Star labels from the EPA are more efficient and may come with rebates or tax credits when you buy them, Minch said.

There was no shortage of advice out there, I discovered, about ways to cut back on CO₂ emissions. Even before Minch's visit, I'd collected stacks of printouts and brochures from environmental websites and utility companies. In a sense, there's almost too much information.

"You can't fix everything at once," John Bauer said when I asked how he and Kyoko were getting along. "When we became vegetarians, we didn't do it all at once. First the lamb went. Then the pork. Then the beef. Finally the chicken. We've been phasing out seafood for a few years now. It's no different with a carbon diet."

Good advice, I'm sure. But everywhere I looked I saw things gobbling up energy. One night I sat up in bed, squinted into the darkness, and counted ten little lights: cell phone charger,

I didn't realize how foolish I was until the next morning: **I'd driven 24 miles in search of a more Earth-friendly lawn mower.**



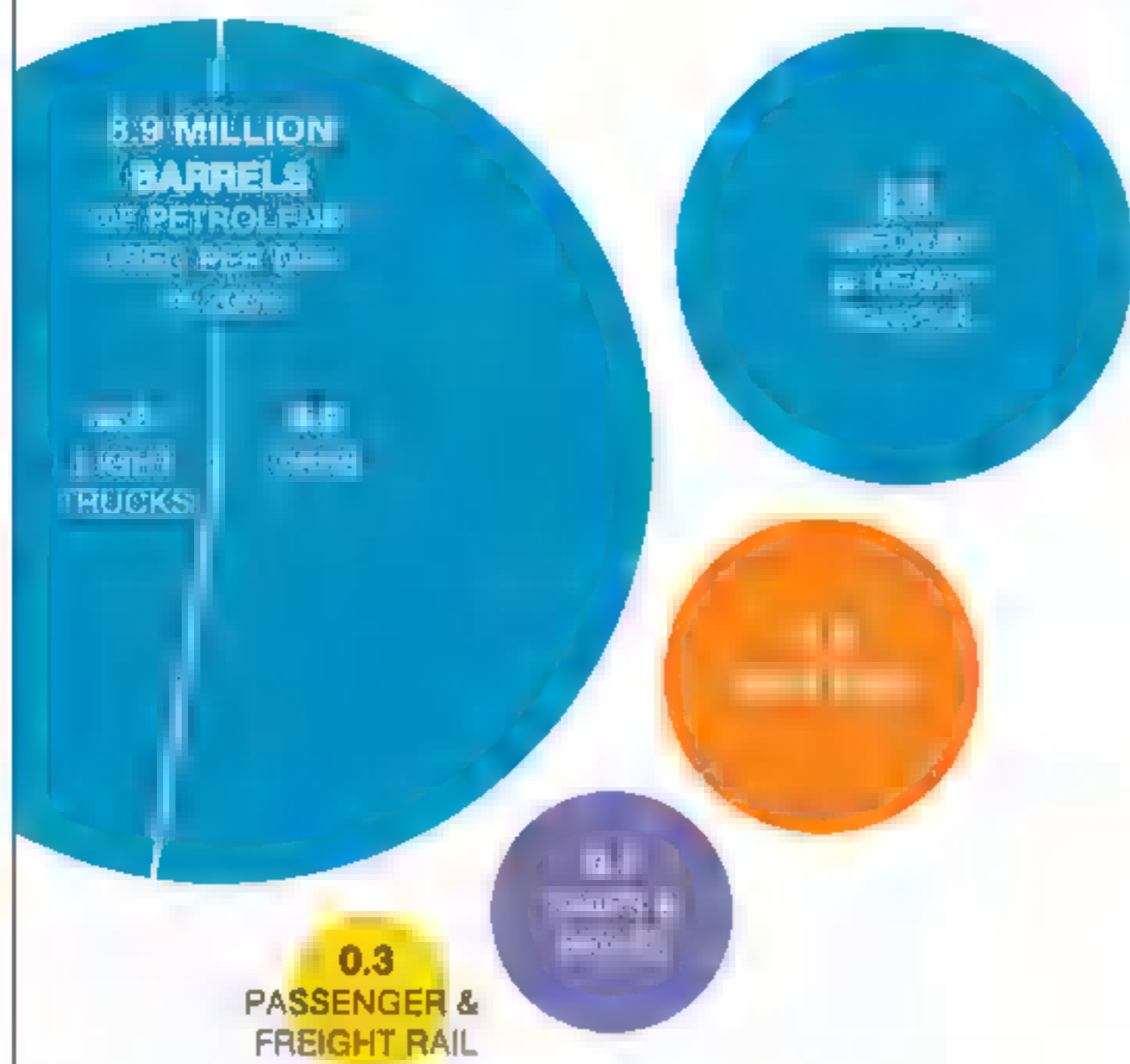
YOU GET TO READ THE PAPER TOO

Commuters on a Metrorail train contribute only half as much CO₂ to the atmosphere as drivers on the Beltway around Washington, D.C. For every mile on the road, an average American car—often carrying just one or two people—pumps a pound of CO₂ into the sky. Emissions from operating an electric train (mainly from coal-fired power plants) are spread among thousands of riders.



TRANSPORTATION TOLLS

Cars and light trucks consume the lion's share of petroleum used for transportation in the U.S. Modest changes in efficiency and driving habits could add up to significant fuel savings.



If we drove our cars 20 fewer miles each week, we could reduce their CO₂ emissions by **107 million tons** each year, a 9 percent decrease.

If we improved our cars' gas mileage by 5 miles a gallon, we could cut their CO₂ emissions by **239 million tons** each year, a 20 percent decrease.

CO₂ AMOUNTS MEASURED IN METRIC TONS
SEAN MCNAUGHTON, NG STAFF

SOURCES: ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2008; DEPARTMENT OF ENERGY, TRANSPORTATION ENERGY DATA BOOK, EDITION 27

Left: Today's internal combustion engines are inefficient at converting fuel to motion. Cars waste up to 85 percent of the energy from the fuel in their tanks, losing a big chunk as heat.

desktop calculator, laptop computer, printer, clock radio, cable TV box, camera battery recharger, carbon monoxide detector, cordless phone base, smoke detector. What were they all doing? A study by the Lawrence Berkeley National Laboratory found that "vampire" power sucked up by electronics in standby mode can add up to 8 percent of a house's electric bill. What else had I missed?

"You can go nuts thinking about everything in your house that uses power," said Jennifer Thorne Amann, author of *Consumer Guide to Home Energy Savings*, who had agreed to be our group's energy coach. "You have to use common sense and prioritize. Don't agonize too much. Think about what you'll be able to sustain after the experiment is over. If you have trouble reaching your goal in one area, remember there's always something else you can do."

AT THIS POINT WE LEFT HOME for a long weekend to attend the wedding of my niece, Alyssa, in Oregon. While we were gone, the house sitter caring for our two dogs continued to read our gas and electric meters, and we kept track of the mileage on our rental car as we drove from Portland to the Pacific coast. I knew this trip wasn't going to help our carbon diet any. But what was more important, after all, reducing CO₂ emissions or sharing a family celebration?

That's the big question. How significant are personal efforts to cut back? Do our actions add up to anything meaningful, or are we just making ourselves feel better? I still wasn't sure. As soon as we returned home to Virginia, I started digging up more numbers.

The United States, I learned, produces a fifth of the world's CO₂ emissions, about six billion metric tons a year. That staggering amount could reach seven billion by 2030, as our population and economy continue to grow. Most of the CO₂ comes from energy consumed by buildings, vehicles, and industries. How much CO₂ could be avoided, I started to wonder, if we all tightened our belts? What would happen if the whole country went on a carbon diet?

Buildings, not cars, produce the most CO₂

in the United States. Private residences, shopping malls, warehouses, and offices account for 38 percent of the nation's emissions, mainly because of electricity use. It doesn't help that the average new house in the United States is 45 percent bigger than it was 30 years ago.

Companies like Wal-Mart that maintain thousands of their own buildings have discovered they can achieve significant energy savings. A pilot Supercenter in Las Vegas consumes up to 45 percent less power than similar stores, in part by using evaporative cooling units, radiant floors, high-efficiency refrigeration, and natural light in shopping areas. Retrofits and smart design could reduce emissions from buildings in this country by 200 million tons of CO₂ a year, according to researchers at Oak Ridge National Laboratory. But Americans are unlikely to achieve such gains, they say, without new building codes, appliance standards, and financial incentives. There are simply too many reasons not to.

Commercial building owners, for example, have had little incentive to pay more for improvements like high-efficiency windows, lights, heating, or cooling systems since their tenants, not they, pay the energy bills, said Harvey Sachs of the American Council for an Energy-Efficient Economy. For homeowners, meanwhile, efficiency takes a backseat whenever money is tight. In a 2007 survey of Americans, 60 percent said they didn't have enough savings to pay for energy-related renovations. If given an extra \$10,000 to work with, only 24 percent said they would invest in efficiency. What did the rest want? Granite countertops.

After buildings, transportation is the next largest source of CO₂, producing 34 percent of the nation's emissions. Carmakers have been told by Congress to raise fuel economy standards by 40 percent by 2020. But emissions will still grow, because the number of miles driven in this country keeps going up. One big reason: Developers keep pushing neighborhoods farther into the countryside, making it unavoidable for families to spend hours a day in their cars. An EPA study estimated

that greenhouse gas emissions from vehicles could increase 80 percent over the next 50 years. Unless we make it easier for Americans to choose buses, subways, and bikes over cars, experts say, there's little chance for big emissions cuts from vehicles.

The industrial sector represents the third major source of CO₂. Refineries, paper plants, and other facilities emit 28 percent of the nation's total. You would think such enterprises would have eliminated inefficiencies long ago. But that isn't always the case. For firms competing in global markets, making the best product at the right price comes first. Reducing greenhouse gases is less urgent. Some don't even track CO₂ emissions.

A number of corporations such as Dow, DuPont, and 3M have shown how profitable efficiency can be. Since 1995, Dow has saved seven billion dollars by reducing its energy intensity—the amount of energy consumed per pound of product—and during the past few decades it has cut its CO₂ emissions by 20 percent. To show other companies how to make such gains, the Department of Energy (DOE) has been sending teams of experts into 700 or so factories a year to analyze equipment and techniques. Yet even here change doesn't come easily. Managers are reluctant to invest in efficiency unless the return is high and the payback time is short. Even when tips from the experts involve no cost at all—such as “turn off the ventilation in unoccupied rooms”—fewer than half of such fixes are acted upon. One reason is inertia. “Many changes don't happen until the maintenance foreman, who knows how to keep the old equipment running, dies or retires,” said Peggy Podolak, senior industrial energy analyst at DOE.

But change is coming anyway. Most business leaders expect federal regulation of CO₂ emissions in the near future. Already, New York and nine other northeastern states have agreed on a mandatory cap-and-trade system similar to the one started in Europe in 2005. Under the plan, launched last year, emissions from large power plants will be reduced over time, as each plant either cuts emissions or purchases credits

Buildings, not cars, produce the most CO₂ in the U.S. **The average new house is 45 percent bigger** than it was 30 years ago.



A GREEN DREAM HOUSE

After a monster tornado swept away their home in 2007, Jill and Scott Eller of Greensburg, Kansas, decided to rebuild using a more efficient design. Their new house, constructed from structural insulated panels like the one Jill is holding, is expected to be much more airtight than standard wood-frame houses. As ■ bonus, the domes should deflect all but the strongest of winds.





BRINGING THE FARM TO THE CITY

If tomatoes, cucumbers, lettuce, strawberries, pumpkins, and other crops can grow on a barge in the Hudson River, then why not on New York City rooftops? That was the idea behind the Science Barge, a prototype of a carbon-neutral hydroponic farm that saves energy by eliminating the need for transportation.

from other companies that cut their emissions. A similar scheme has been launched by the governors of California and six other western states and the premiers of four Canadian provinces.

So how do the numbers add up? How much CO₂ could we save if the whole nation went on a low carbon diet? A study by McKinsey & Company, a management consulting firm, estimated that the United States could avoid 1.3 billion tons of CO₂ emissions a year, using only existing technologies that would pay for themselves in savings. Instead of growing by more than a billion tons by 2020, annual emissions in the U.S. would drop by 200 million tons a year. We already know, in other words, how to freeze CO₂ emissions if we want to.

Not that there won't still be obstacles. Every sector of our economy faces challenges, said energy-efficiency guru Amory Lovins of the Rocky Mountain Institute. "But they all have huge potential. I don't know anyone who has failed to make money at energy efficiency. There's so much low-hanging fruit, it's falling off the trees and mashing up around our ankles."

BY THE LAST WEEK IN JULY, PJ and I were finally getting into the flow of the reduced carbon lifestyle. We walked to the neighborhood pool instead of driving, biked to the farmers market on Saturday morning, and lingered on the deck until dark, chatting over the chirping of the crickets. Whenever possible I worked from home, and when I commuted I took the bus and subway. Even when it got hot and humid, as it does in Virginia in July, we were never really uncomfortable, thanks in part to the industrial-size ceiling fan we installed in the bedroom in late June.

"That fan's my new best friend," PJ said.

Our numbers were looking pretty good, in fact, when we crossed the finish line on August 1. Compared with the previous July, we slashed electricity use by 70 percent, natural gas by 40 percent, and reduced our driving to half the national average. In terms of CO₂, we trimmed our emissions to an average of 70.5 pounds a day, which, though twice as much as we'd targeted

as our goal, was still half the national average.

These were encouraging results, I thought, until I factored in emissions from our plane trip to Oregon. I hadn't expected that a modern aircraft packed with passengers would emit almost half as much CO₂ per person as PJ and I would have produced if we'd driven to Oregon and back in the CR-V. The round-trip flight added the equivalent of 2,500 pounds of CO₂ to our bottom line, more than doubling our daily average from 70.5 pounds of CO₂ to 150 pounds—five times our goal. So much for air travel.

By comparison, the Bauers did significantly better, though they also faced setbacks. Since their house is all electric, Kyoko Bauer had tried to reduce her use of the clothes dryer by hanging laundry on a rack outside, as she and John had done when they lived in arid Western Australia. But with their busy three-year-olds, Etienne and Ajanta, she was doing as many as 14 loads a week, and it took all day for clothes to dry in Virginia's humid air. "It wasn't as convenient as I hoped," she said. "I had to race home from shopping a couple of times before it started to rain." Their bottom line: 97.4 pounds of CO₂ a day.

For the Freedmans, driving turned out to be the big bump in the road. With four cars and everyone commuting to a job every day—including Ben and Courtney—they racked up 4,536 miles during the month. "I don't know how we could have driven less," Susan said. "We were all going in different directions and there wasn't any other way to get there." Their bottom line: 248 pounds of CO₂ a day.

When we received our electric bill for July, PJ and I were pleased that our efforts had saved us \$190. We decided to use a portion of this windfall to offset the airline emissions. After doing a little homework, we contributed \$50 to Native Energy, one of many companies and nonprofits that save CO₂ by investing in wind farms, solar plants, and other renewable energy projects. Our purchase was enough to counteract a ton of jet emissions, roughly what we added through our trip and then some.

We can do more, of course. We can sign up

I hadn't expected that a **modern aircraft would emit almost half as much CO₂ per person** as we would have produced if we'd driven to Oregon and back in our car.



DOING LESS HARM IN FLIGHT

Because aircraft exhaust is released at high altitude, scientists say it has a greater impact on climate than the same emissions at ground level. At a General Electric test site in Peebles, Ohio, technicians check connections before firing up a GEnx-2B development engine. Built with carbon-fiber parts, the test model uses less fuel and produces 15 percent less CO₂ than predecessors.

with our utility company for power from regional wind farms. We can purchase locally grown foods instead of winter raspberries from Chile and bottled water from Fiji. We can join a carbon-reduction club through a neighborhood church, Scout troop, Rotary Club, PTA, or environmental group. If we can't find one, we could start one.

"If you can get enough people to do things in enough communities, you can have a huge impact," said David Gershon, author of *Low Carbon Diet: A 30-Day Program to Lose 5,000 Pounds*. "When people are successful, they say, Wow, I want to go further. I'm going to push for better public transportation, bike lanes, whatever. Somebody called this the mice-on-the-ice strategy. You don't have to get any one element to work, but if you come at it from enough different directions, eventually the ice cracks."

WILL IT MAKE ANY DIFFERENCE? That's what we really wanted to know. Our low carbon diet had shown us that, with little or no hardship and no major cash outlays, we could cut day-to-day emissions of CO₂ in half—mainly by wasting less energy at home and on the highway. Similar efforts in office buildings, shopping malls, and factories throughout the nation, combined with incentives and efficiency standards, could halt further increases in U.S. emissions.

That won't be enough by itself, though. The world will still suffer severe disruptions unless humanity reduces emissions sharply—and they've risen 30 percent since 1990. As much as 80 percent of new energy demand in the next decade is projected to come from China, India, and other developing nations. China is building the equivalent of two midsize coal-fired power plants a week, and by 2007 its CO₂ output surpassed that of the U.S. Putting the brakes on global emissions will be more difficult than curbing CO₂ in the United States, because the economies of developing nations are growing faster. But it begins the same way: By focusing on better insulation in houses, more efficient lights in offices, better gas mileage in cars, and smarter processes in industry. The potential

exists, as McKinsey reported last year, to cut the growth of global emissions in half.

Yet efficiency, in the end, can only take us so far. To get the deeper reductions we need, as Tim Flannery advised—80 percent by 2050 (or even 100 percent, as he now advocates)—we must replace fossil fuels faster with renewable energy from wind farms, solar plants, geothermal facilities, and biofuels. We must slow deforestation, which is an additional source of greenhouse gases. And we must develop technologies to capture and bury carbon dioxide from existing power plants. Efficiency can buy us time—perhaps as much as two decades—to figure out how to remove carbon from the world's diet.

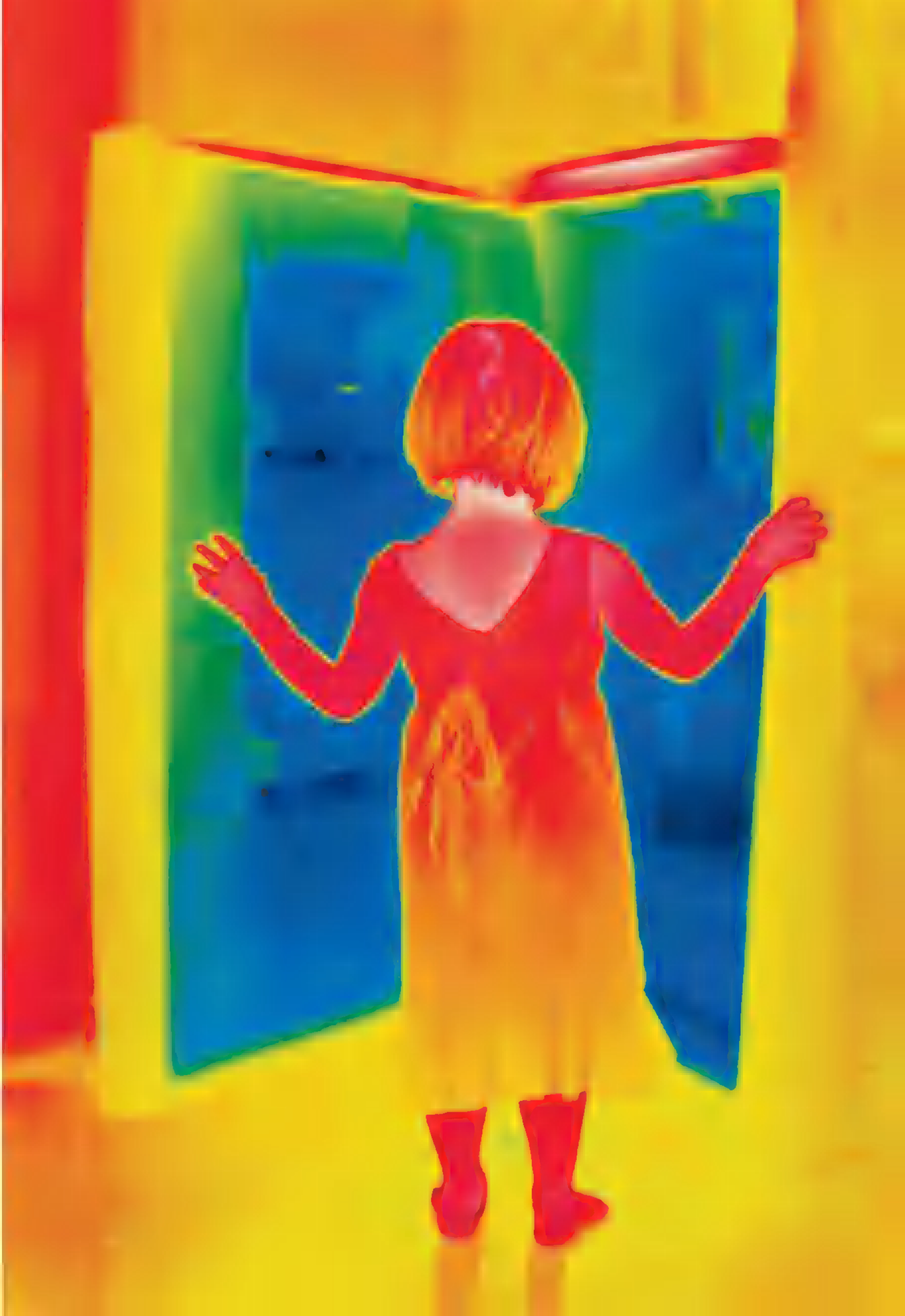
The rest of the world isn't waiting for the United States to show the way. Sweden has pioneered carbon-neutral houses, Germany affordable solar power, Japan fuel-efficient cars, the Netherlands prosperous cities filled with bicycles. Do Americans have the will to match such efforts?

Maybe so, said R. James Woolsey, former director of the CIA, who sees a powerful, if unlikely, new alliance forming behind energy efficiency. "Some people are in favor of it because it's a way to make money, some because they're worried about terrorism or global warming, some because they think it's their religious duty," he said. "But it's all coming together, and politicians are starting to notice. I call it a growing coalition between the tree huggers, the do-gooders, the sodbusters, the cheap hawks, the evangelicals, the utility shareholders, the mom-and-pop drivers, and Willie Nelson."

This movement starts at home with the changing of a lightbulb, the opening of a window, a walk to the bus, or a bike ride to the post office. PJ and I did it for only a month, but I can see the low carbon diet becoming a habit.

"What do we have to lose?" PJ said. □

Blue signifies the cool air escaping as four-year-old Eva Turner dawdles at the fridge. That's not so bad: Today's models use a third less energy than those of 30 years ago.



THE SAVINGS, THE COSTS

A CARBON REDUCTION PLAN

By investing in new technology or adopting approaches already available, we could cut U.S. greenhouse gas emissions by three billion tons a year, more than offsetting the increases expected by 2030 as our population and economy grow. And the money saved from efficiencies in how we use energy (below) could help pay for improvements in how we generate energy (right).

KEY SECTORS

POWER INDUSTRY

1,127 million tons per year

OTHER MEASURES
RENEWABLE ENERGY
521



BUILDINGS

729 million tons per year

OTHER
LIGHTING
490
239



INDUSTRY & WASTE

520 million tons per year

OTHER
REDUCING DIRECT EMISSIONS
247
273



FORESTRY & AGRICULTURE

486 million tons per year

OTHER
FOREST RECOVERY
207
279



TRANSPORTATION

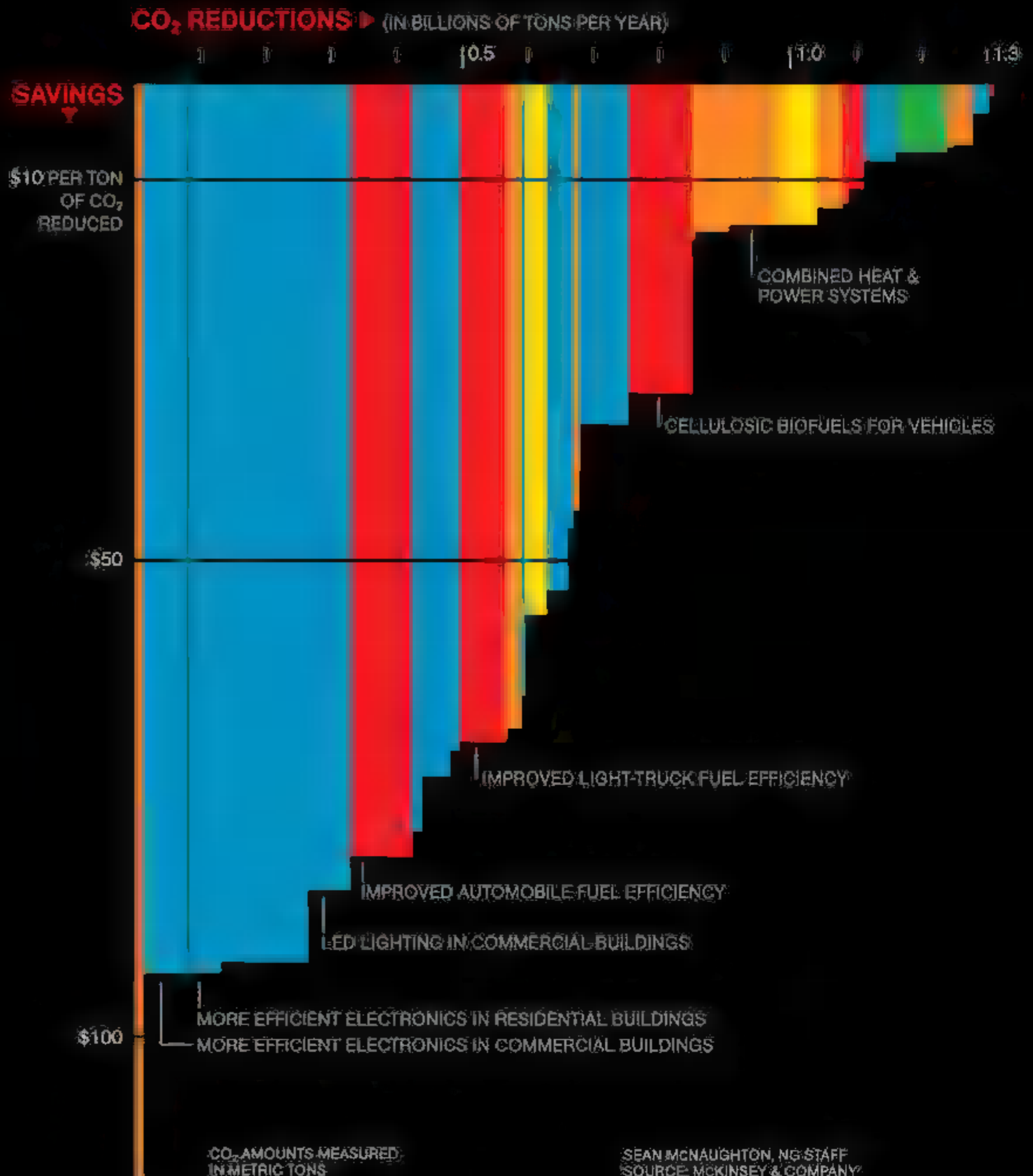
357 million tons per year

OTHER
FUEL EFFICIENCY
160
197



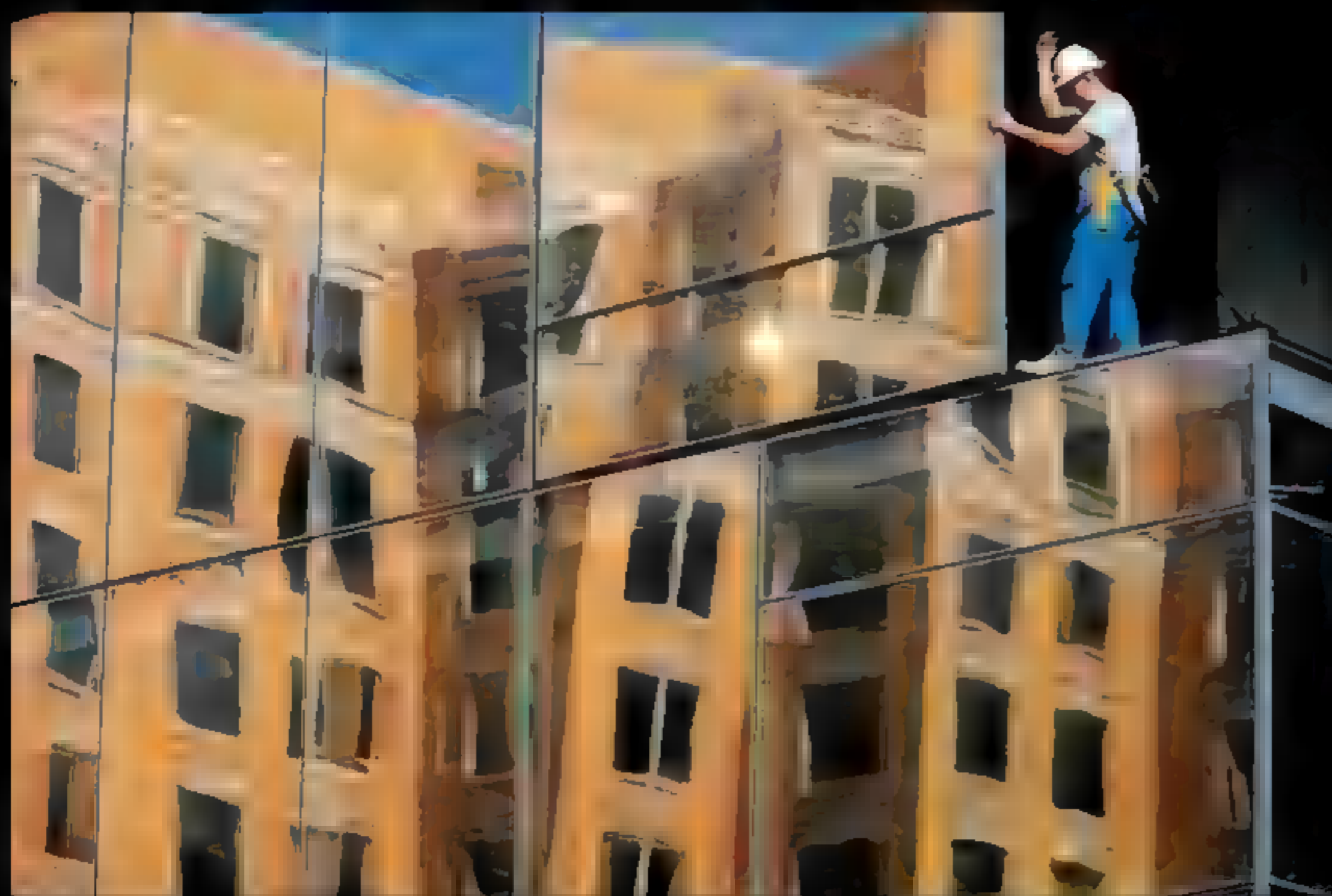
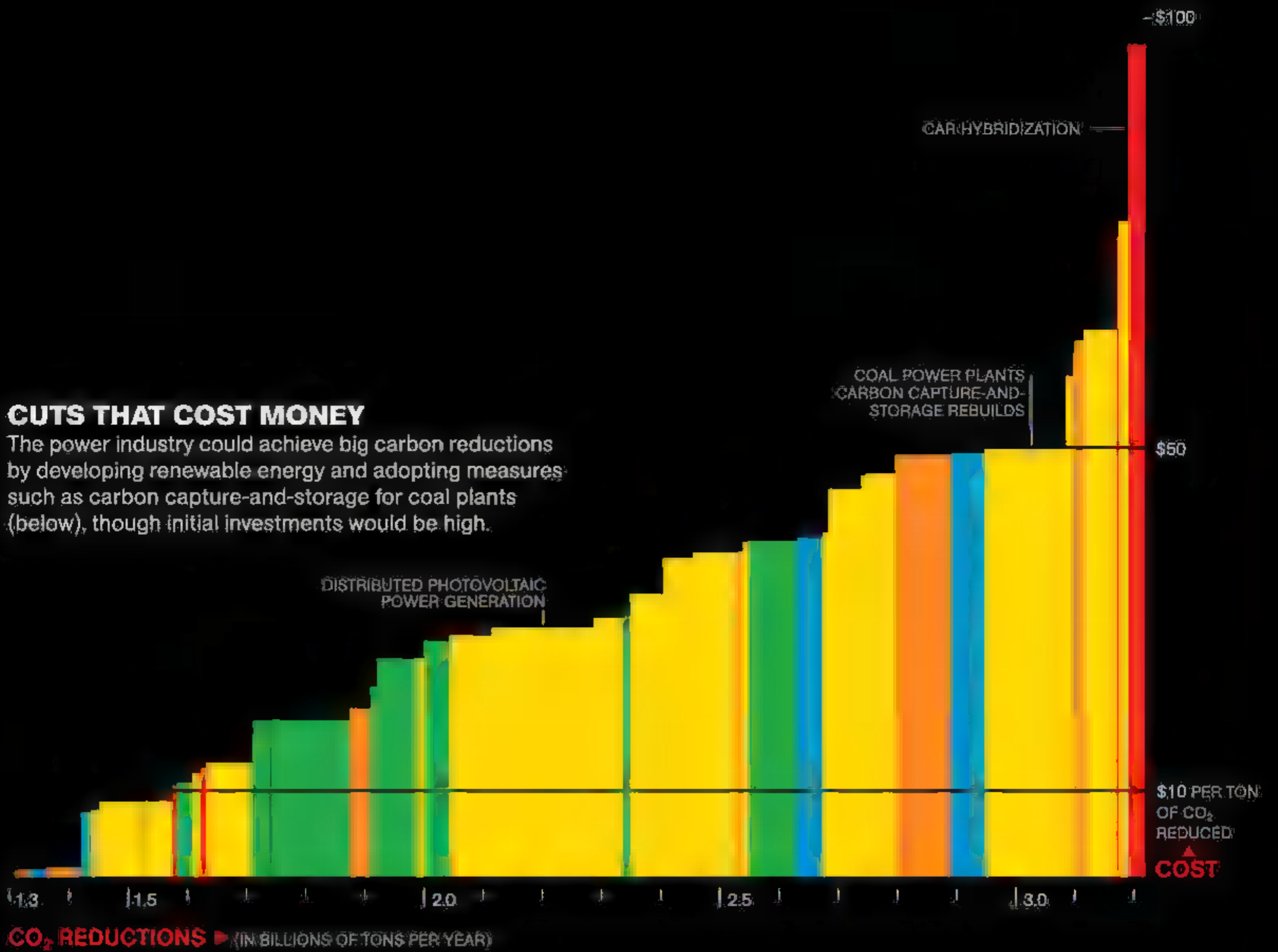
CUTS THAT SAVE MONEY

About 40 percent of possible cuts could come from measures that save billions of dollars a year (below). Most of these savings are found in building improvements, such as more efficient lighting, and transportation improvements like better fuel efficiency.



CUTS THAT COST MONEY

The power industry could achieve big carbon reductions by developing renewable energy and adopting measures such as carbon capture-and-storage for coal plants (below), though initial investments would be high.



A worker in Washington, D.C., installs a triple-glazed window in a structure designed to meet strict "green building" standards. Advanced lighting, heating and cooling, and water systems, and a green roof contribute to a small carbon footprint, and can reduce energy costs up to 75 percent. But many firms hesitate to invest in efficiency if up-front costs seem too high or payback times too long.



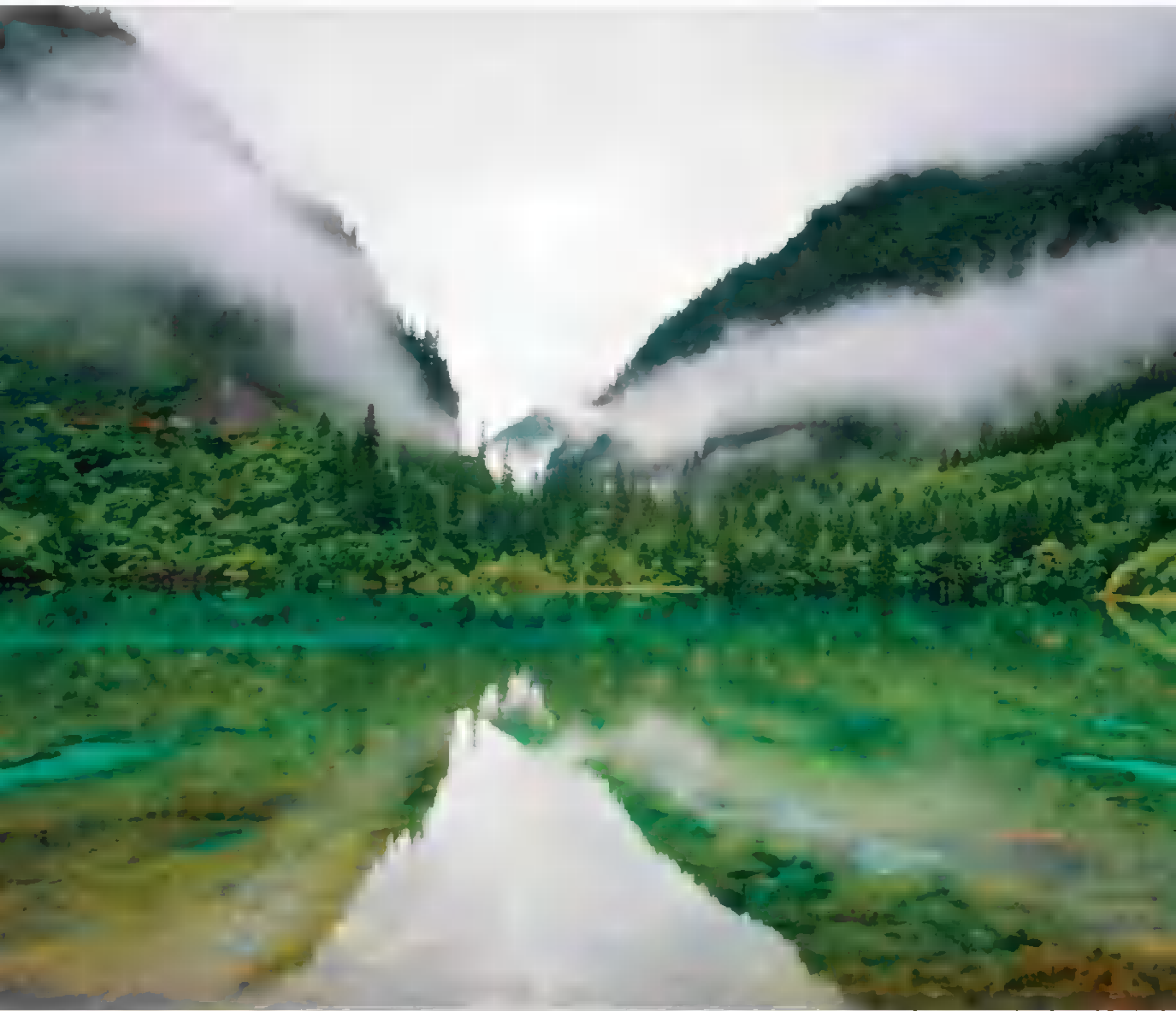
This is the other China. High in the mountains of Sichuan Province, in Jiuzhaigou Nature Reserve, rare plants and animals find sanctuary, and millions of visitors have discovered cool, clear, sapphire-and-emerald-tinted waters, far removed from the sooty industrial sprawl that consumes lands and lives below.

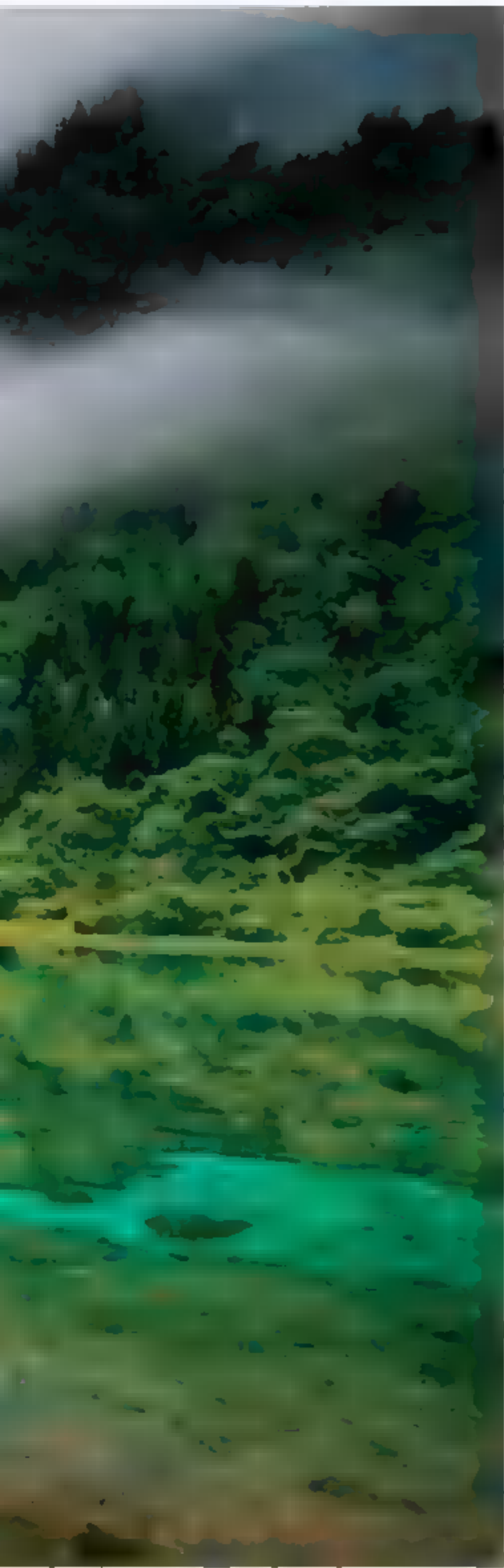


Mystic Waters

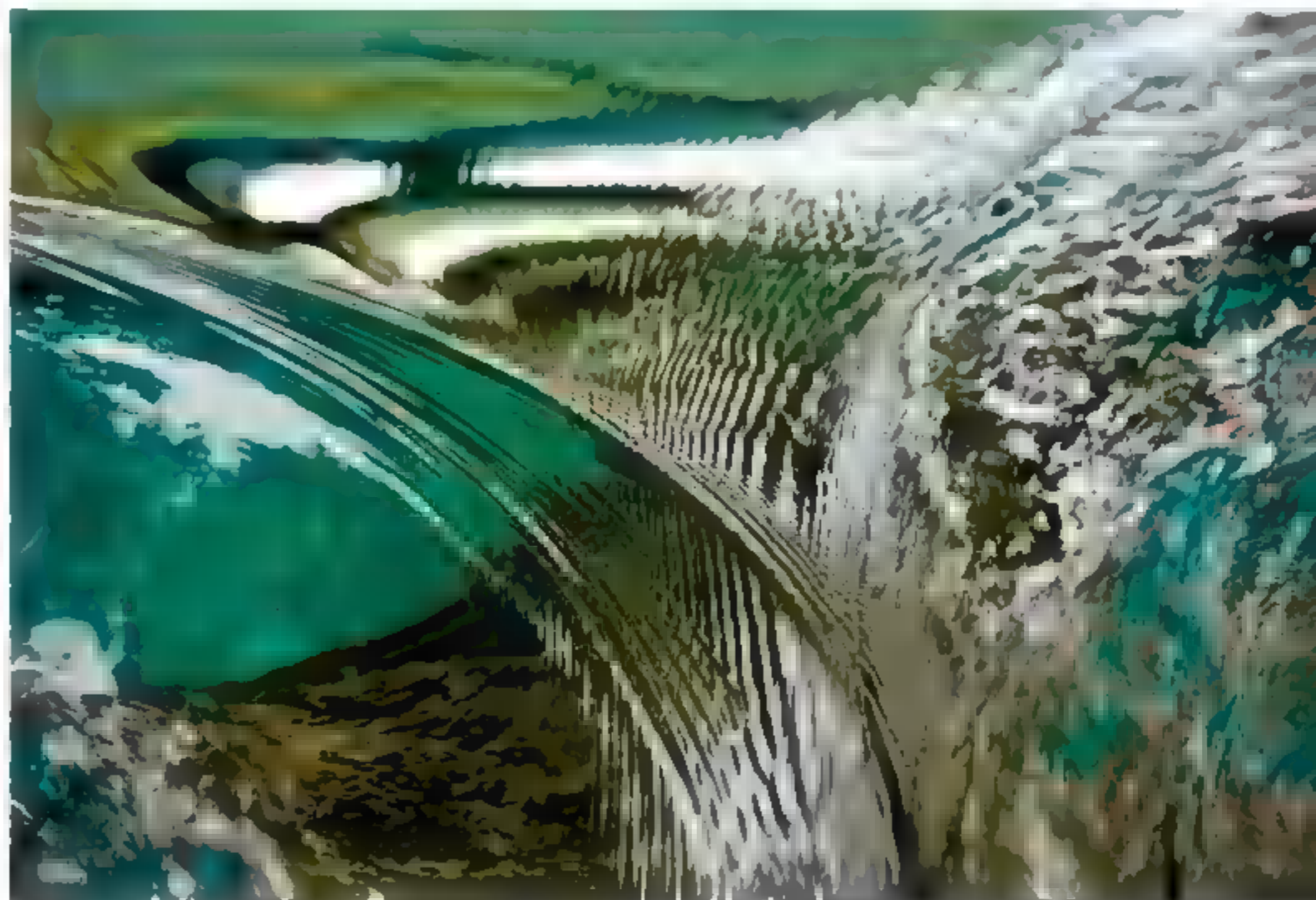
Photographs by Michael Yamashita

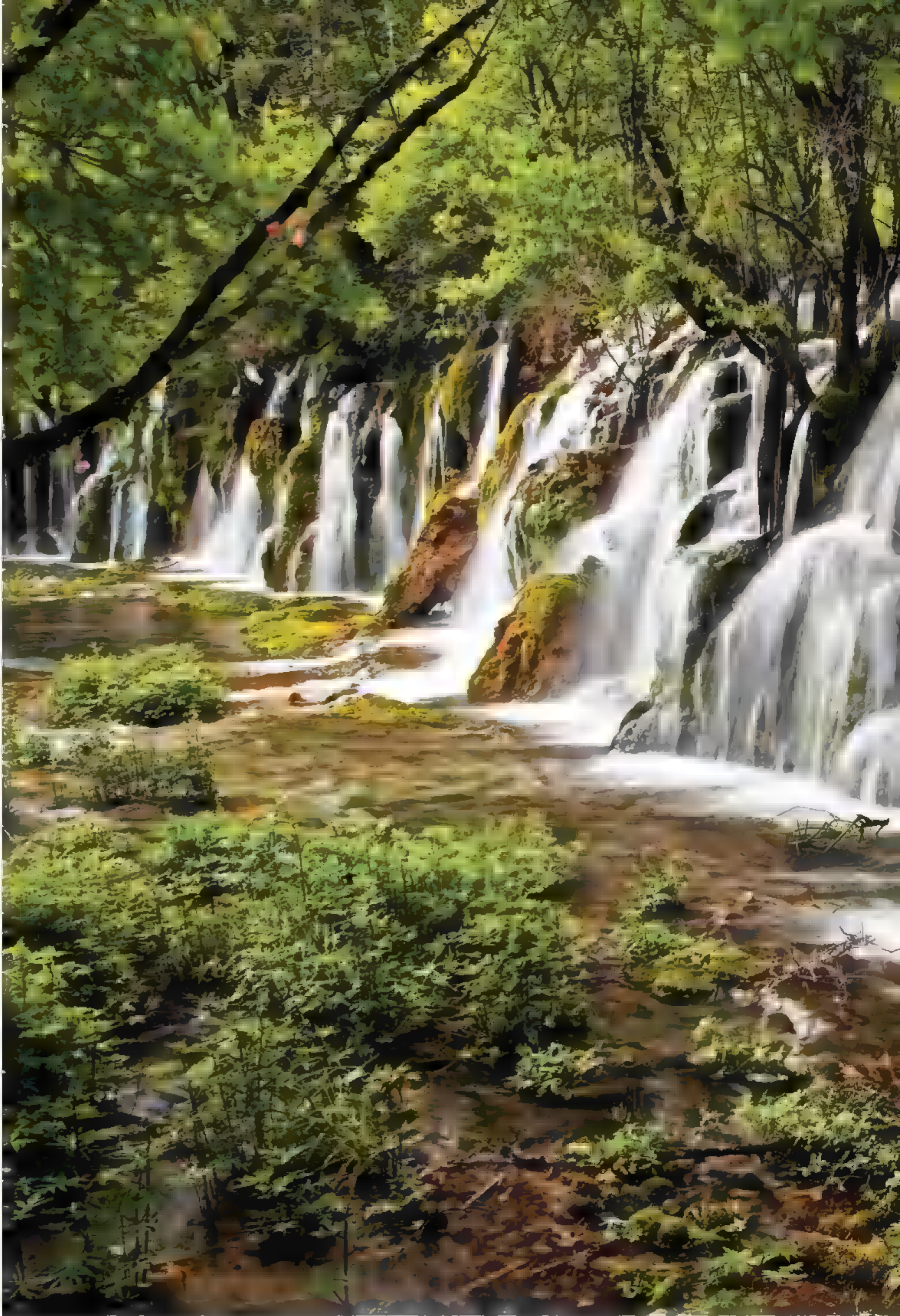
Jiuzhaigou





Crystal pools glisten among drifts of mist and legend. In an ancient love story ■ Tibetan god gave ■ mirror polished by clouds and wind to a goddess, who dropped it. Shards scattered, forming Jiuzhaigou's 118 lakes.

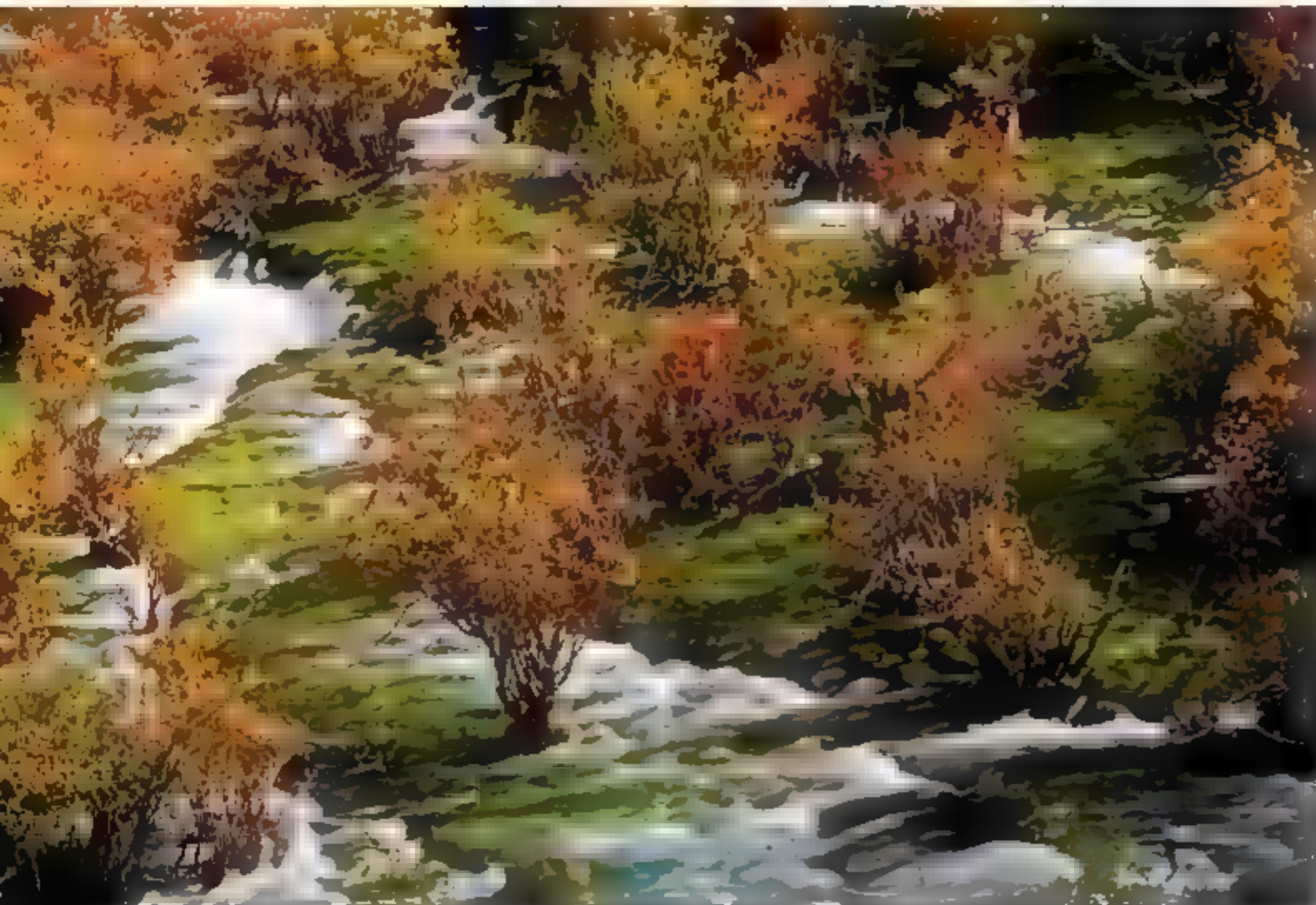






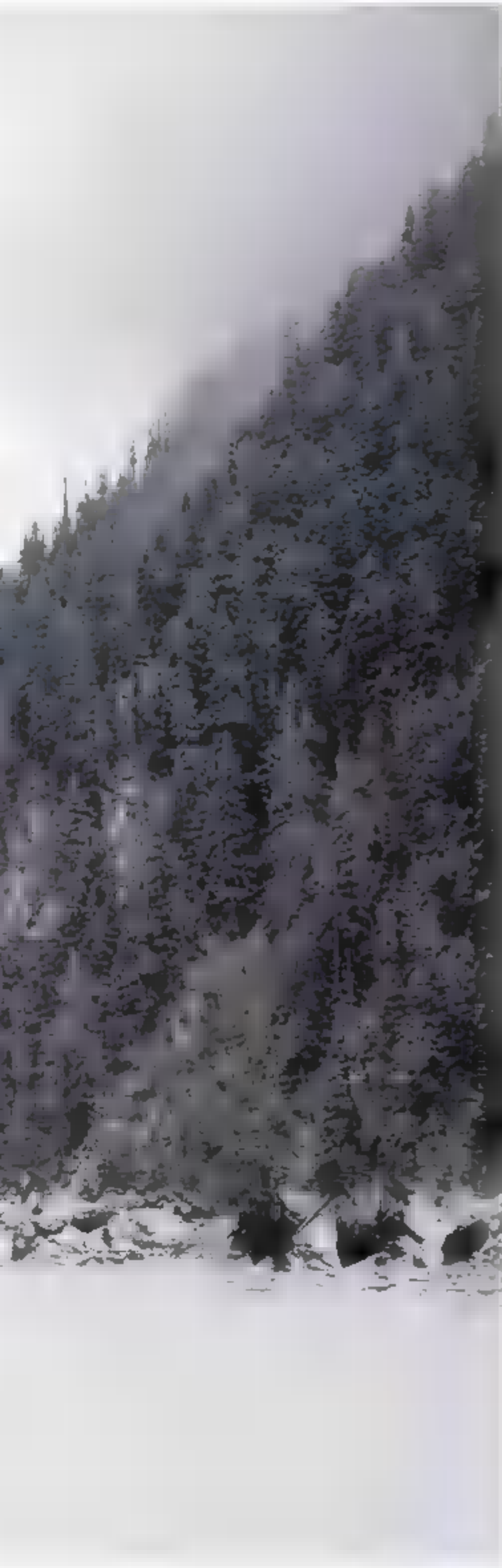
The air rings with water music as snowmelt and spring rains sluice down the Rize Valley, tumbling in broad cataracts from one brimful lake to another. Some 23 feet high, Arrow Bamboo Falls spans nearly 500 feet.

A haphazard flourish of hardy plants caps a broken tree trunk submerged in Panda Lake (right), and autumn-tinged brush stands unbowed as the waters of Shuzheng Falls spill past (below). Loggers discovered the region's mother lode of timber in the 1960s and began cutting, especially old-growth pine. Alarmed by the loss, the government created a nature reserve here 31 years ago.









Dusted in winter white, a timeworn cypress looms over Long Lake, some 10,000 feet up in the Min Mountains (left). A summer sunrise gleams on the foaming ten-story plunge of Pearl Shoals Falls (below).





Morning stillness reflects heaven and earth, tinted by mineral deposits and aquatic plant life in Five Flower Lake. The Chinese call this landscape magical. "Nowhere else under the sky," they say, "can match Jiuzhaigou."



To Paradise, by the Busload

Essay by Edward Hoagland **Jiuzhaigou**

Jiuzhaigou means “valley of nine villages,” because it once harbored nine, but other numbers are more significant now. About 80 hotels are clustered cleanly at the mouth of a Y-shaped, 20-mile-long valley in the Min Mountains of central China, where 280 buses wait to shuttle this day’s 18,000

or so visitors up the very pretty route, past a chain of flower-colored, ribbon lakes and finery waterfalls, underneath escarpments chevroned with maple, spruce, or bamboo forests cut by the talus of old landslides. (Clouds permitting, it’s just a 40-minute flight from Chengdu, the tree-shaded jumping-off point in Sichuan Province nestled near some of the major germinating sites of China’s civilization 3,000 years ago.) Boardwalks circuit the little lakes and reedy creeks, and the buses stop to let parties of trippers stroll at their own pace. Then they queue to catch another and continue on.

Glaciers carved the two valleys that join the Shuzheng Valley—the Zechawa and the Rize, which climb to around 10,000 feet—into the classic U shapes one knows from Yosemite, Jiuzhaigou’s “sister” park in the United States, with walls that discourage casual scrambling yet do not tower severely enough to distract from the extraordinary limy beauty of the modest waterways underneath. The geology in this part of the Tibetan Plateau is not granite, like the Sierras, but seabed, like our Rockies, so its limestones, dissolving, color the waters emerald or turquoise in a certain light or enhance the mirroring of an azure sky. Avalanches, in blocking the creeks, sculpted the lakes, but by legend, sky goddesses dropped their cosmetics into several, and mermaids swam in others. Calcium carbonate deposits on the bottom sometimes assumed fanciful shapes—sleeping dragons or whatnot.

The road ascends from about 6,000 feet at

the valley entrance, splits at Nuorilang, where a tourist shopping center and cafeteria are set up, and terminates in the case of the left fork at a wilderness lake, wiggly and long, and in the case of the right at a “primeval forest,” in the language of the brochures, which translates as groves that were not leveled by loggers before the area’s tourism possibilities were recognized. Jiuzhaigou Nature Reserve, China’s flagship of its type, was designated a World Heritage site in 1992 by UNESCO, after logging sprees threatened to degrade it.

Costumed Tibetans sell trinkets and postcards at the end of each fork, and the boardwalks loop more ambitiously than usual. Along the bus route there’s a Golden Bell Lake, Grass Lake, a Pearl Shoals Falls, Arrow Bamboo Falls, a Five Flower Lake and Five Colored Pond, a Sparkling Lake, Tiger Lake, Bonsai Lake, Swan Lake, Rhinoceros Lake, Double Dragon Lake, Reed Lake, Panda Lake, and Mirror Lake, which reflects, as the others do, the menagerie of the clouds, the birches, willows, and pines, the tinctures and hues of sunrise and sunset on rock faces and cliffs. Five shades of green, three of scree. Although the names sound promotional, Buddhist mysticism, and certainly the Bon religion that predated it and underlies it for many Tibetans, animated these lakes and rivers with spirits that the mineralized waters might fortuitously personify, whether mermaid or monster.

A flyer explains that the myriad lakes and



On the edge of the Tibetan Plateau, the reserve protects 278 square miles of what the UN Environment Programme calls “the most biologically diverse temperate forest in the world.”

tarns of Mount Wunuosemo and Mount Dage resulted when “the goddess Wonosmo dropped a mystical mirror, a gift of love from the god Dag.” The true Tibetan narratives no doubt had more intriguing meanings attached to them, a spectrum equivalent to the colors this upthrust seafloor’s chemistry bestows upon the waters flowing through. The Baihe, or White River, rustles by the park’s entrance to join the White Dragon River (named for a bluff), and then the mightier Jialing, and finally the gouged and mangled, gigantic Yangtze itself.

The intensely lovely little Jiuzhaigou complex of chromatic lakes in glacially awled mini-valleys is already nearly bereft of the tubby black-and-white pandas that once thrived here—an animal now trumpeted by the government as “our national treasure” but displaced wholesale by heedless logging and a die-off of bamboo during the last decades of the past

Novelist and essayist Edward Hoagland is known for his nature writing. Longtime contributor Michael Yamashita specializes in documenting Asia.



Nearly 40 miles of wooden walkways, stairs, and observation decks connect tour bus routes to prime attractions like Pearl Shoals Falls. On peak days thousands of eager visitors strain Jiuzhaigou's limits.

century; more than one Tibetan described the decimation to me. Masticating bamboo shoots in a semireclining position, like a sea otter munching mollusks while lounging on its back, the panda has become an endearing emblem for conservationists worldwide and carries a heavy load in this supercharged robber-baron economy. Conservation would be a novel concept to anyone unacquainted with what is supposed to be preserved, such as wildness, wildlife, natural beauty. I noticed at the Beijing Zoo that the visitors seemed to have no feeling one way

or another for the apparent thirst of the bears in their waterless pit or the metronomic jackals and wolves ticktocking in the heat. In the greenery of Chengdu's parks, the din of bird-song was so frenetic and dense as to imply an extreme scarcity of nesting spaces elsewhere. Only recently did the People's Republic bar the serving of delicacies like bears' paws at official government banquets, about the same time the Dalai Lama, in his Indian exile, urged his followers to end the wearing of tigers' or leopards' skins. Edicts can't generate a conservation ethic,

however. Jiuzhaigou's chief scientist told me he still found snow leopard skins openly displayed for sale nearby in Songpan for the equivalent of a hundred bucks—a month's wages for a laborer. And in Jiuzhaigou's Zaru Valley—less developed than the Shuzheng, where two or three relic pandas may yet transit or hang out and a peacefully bouncing creek is bedded in pretty rocks, topped by thousand-foot serrated escarpments, with the holy mountain Zayizaga behind them—three men were hiking out, lugging across their backs sacks of illegally collected herbs, plucked from protected areas upstream, for sale to tourists, all but 10 percent of whom at Jiuzhaigou are Chinese. They asked me for a lift.

THE BLACK-MASKED EYES of the pandas ubiquitously displayed on placards around the region look more tear-stained than cuddly like a nursery toy. A million of these must have been manufactured by now for every specimen that remains, uncute, in the wild. And millions of people must somehow be transported out of the slag-heap landscapes and lung-stinging air lower down to see pristine, glistening water and rainbow-feathered birds darting in sweet mountain breezes under the Tibetan Plateau's cosmic skies to bulk up a national policy of trying to save something of creation before it's destroyed. But how can millions be queued up to experience wilderness without erasing it?

Once the panda's range extended clear into Burma. Now, in zoos, a panda tends to lie as limp as a throw rug over the artificial landscaping that has been provided, splotched black and white as if with finger painting or costumed for Halloween or clowning. Yet the cut of the mouth is stoic, not toylike, and the light-and-shadow coloring conveys the ambiguity of being neither white nor black but both, like sunshine falling through a forest—a camouflage therefore reverberant of grief, since the forests are mostly gone.

Jiuzhaigou's sinuous lakes and popping waterfalls may be preserved like the imperial tokens of forgotten dynasties in Beijing's Forbidden City, mined for tourism instead of export—a

sliver of habitat for golden snub-nosed monkeys, hog badgers, musk deer, lynx, civets, the littler red species of panda, and rhesus macaques. I wouldn't suggest that Native Americans or their wildlands endured a kinder transition, but China's industrialization has been extraordinarily compressed. With 2,000-plus nominal nature reserves—each provincially managed because no national park service yet exists—the country is keeping its wildest scenery eclipsed but unblitzed. Yet the avalanche-sculpted waterways of Jiuzhaigou are being reinforced at their dam ends and are easily reached from the Blue Sky parking lot near Mirror Cliff.

Solitude is almost a vestigial pleasure, now that electronic entertainment can accompany us anywhere. Yet, if not from God, aren't we borrowing our planet from our children, as the saying goes, and if so, shouldn't we deliver it to them in habitable shape? Neither Marxism nor Buddhism would dispute that contention, except for the changing concept of what to think of as habitable. If we consider ourselves not just preeminent among but preemptive of any other form of life—if people simply do not care, apart from culinary calculations, when few unfarmed fish are left, or roadless ridgelines without windmills pinwheeling on them, or snowfields or meadowlarks—then the few who do care and who wish to relax from the pell-mell continuum may have to obtain surround-sound film clips of Ansel Adams-type wilderness imagery for their wall-scale computer screens. Video virtualizations corresponding to white noise may outsell these because, in fact, we're getting to prefer virtualizing so fast. But queues of citizens will still be trundled in, as at Jiuzhaigou, to tread the boardwalks and purchase tchotchkes from costumed hawkers at the end of the bus route. The harlequin pattern of crib and playroom pandas, like tiger camouflage, is with us to stay. Jungle-striped but captive-bred, the cats remain as *de rigueur* for zoos as pandas are going to be after the trees are gone, much like the replicated Tibetan monasteries with correct facades and paint schemes but no monks living inside. □

AMID A SEA OF CONFLICT, THE SINAI OFFERS

THE



PLEASURE, SPIRITUAL REFUGE, AND—POTENTIALLY—HARMONY.

SINAI

A Separate Peace

BLUE WATERS of the Gulf of Aqaba ripple between Saudi Arabia (far shore) and resorts lining the eastern coast of Egypt's Sinai Peninsula. Long both holy land and battleground, the wedge of desert has become a mecca for pleasure-loving travelers and profit-seeking developers.





AT DAWN on Mount Sinai, camels rest and Said Spayel prays. Tourism on the peak has been a boon to Bedouin like Spayel: He charges about \$15 a person for camelback rides to the summit. Thousands of other Bedouin live in the desert, where opportunities to earn cash are few.





DECKED OUT in baubles and crowns to mimic ancient Egyptian royalty, Russian and Italian staff performers from Domina Coral Bay resort pose for photos with guests. Beach resorts ship patrons to the sands near Sharm el Sheikh for dinner and entertainment under the desert sky.

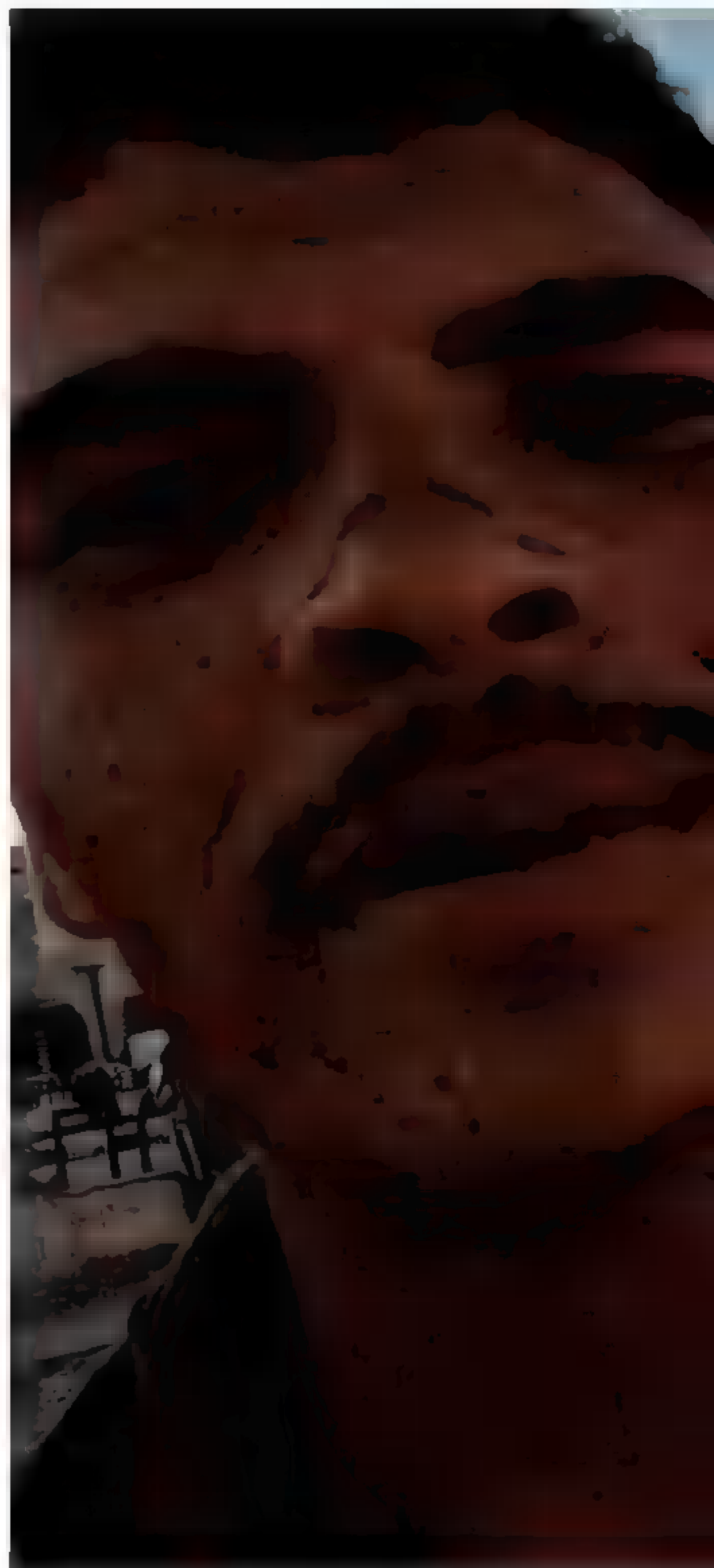
By Matthew Teague
Photographs by Matt Moyer

All seemed quiet in the coastal village of Taba. On this night, as on every other, the sun dropped west behind the Sinai mountains so that darkness slid downhill, gathering speed as it approached the sea. At the Hilton resort, guests shrugged off bikinis in favor of evening dresses and sport coats. The desert wind blew cold at night in October, so the hotel's management drained the seawater pool until morning.

The Red Sea resort offered a miniature model of the Sinai dream—the dream of a Middle East where old enemies trade land for peace and terrorism for tourism. The British ran the hotel, Egyptians staffed it, Europeans and Russians—and many Israelis—frequented it. Outside, Egyptian and Israeli flags fluttered alongside each other. True, a month earlier the Israeli government had warned of an imminent terrorist attack, but such warnings always came and went. Here visitors could forget that the two longtime enemies had traded possession of the peninsula several times in the past half century or so. During wars in 1956, 1967, and 1973 Egypt and Israel stormed across the peninsula; in 1979 the two countries signed a peace deal, and Israel yielded control to Egypt once more. The pact still stands after 30 years.

Sinai has always been a place of such paradox—a harsh land of ethereal beauty, of both strife and symphony. Despite all the peninsula's geopolitical importance, for instance, its largest population is the group that cares least about national identity: the Bedouin. During the back-and-forth battling of recent decades, the tribal people blended so well into the landscape that they almost seemed a natural feature, like dunes trodden by conquerors.

As the evening deepened, guests migrated



BITTERNESS SEETHES in the streets of El Arish. Joblessness in Sinai's north has risen as investors have turned south, along with visitors wary of violence in nearby Gaza. President Mubarak (on billboard) has been a target of the anger: Rioters destroyed his party offices in 2007.



from the restaurants to the casino, bar, and discotheque. Everyone celebrated Sinai-related holidays on this weekend: The Egyptians remembered their army's thrust into the peninsula in the 1973 Yom Kippur War, and the Israelis commemorated their ancestors' biblical journey through the desert. In recent years people had taken to calling this coast the Red Sea Riviera. It embraced a decadence and an abandon that set it apart from the rest of Egypt.

The Israeli border lay just a few yards away.

Beyond it, in Elat, off-duty firefighter Shachar Zaid emerged from a movie theater where he and his wife had just watched an American film about firefighters. That's when a muffled sound rolled through the town: *whomp*.

Zaid ran with his wife toward the sound, toward the border. Along the way he met his

Matthew Teague is a staff writer for Philadelphia Magazine. Matt Moyer has lived in Cairo, where he photographed the plight of child laborers.

For millennia the Sinai Peninsula has served as a land bridge and also a metaphysical bridge between man and God.

off-duty fire chief, changing into his uniform in his car, and six other firefighters arriving with the town's three trucks. Zaid climbed atop one of the ladder trucks with his chief, and they approached the border without knowing exactly what lay beyond. Egyptian soldiers, equally unsure what was happening, stood blocking the checkpoint with automatic rifles.

Staring at each other across an invisible line, the Egyptians and Israelis encountered a sudden international dilemma. How they acted that night in 2004 would become emblematic of everything that had come before in Sinai's past and everything that lay ahead. The Egyptians had to decide whether to defend their sovereignty against an old enemy. And the Israeli firefighters faced their own choice: Whether to stage an eight-man incursion onto Arab soil.

For millennia the Sinai Peninsula has served as a bridge. A land bridge for people moving from one continent to another, yes, but also a metaphysical bridge between man and God. The forebears of the three great monotheistic religions are all said to have sought refuge in this triangular desert. According to the Bible, Moses received his assignment in Sinai when God spoke to him from the burning bush, then wandered the desert with his people for 40 years. As a child, Jesus and his family fled into Sinai to escape a jealous King Herod's wrath. Early Christians hid from Roman persecutors among the peninsula's lonely mountains, establishing some of the first monastic communities.

The oldest continuously operating Christian monastery in the world—St. Catherine's—sits at the foot of Mount Sinai, where Moses is said to have received the Ten Commandments. It is Sinai's spiritual hub. "Sinai is the only place where we have icons from the sixth century to the present," Father Justin, a monk, told me. He walked in long black robes, his silver beard reached halfway to his thin waist, and his face glowed, all of which recalled Moses himself descending with the stone tablets. The monastery compound is embraced by mountain peaks, all pink-faced, as though flushed by the high elevation. Among

the basilica, the library, and other structures, Justin pointed out a less expected one with a small crescent on top: a mosque.

According to monastic tradition, Muhammad also took refuge in Sinai, during the seventh century, and stayed at the monastery. Today the monks live alongside Muslim Bedouin who work in the monastery, and Justin said the relationship—contradictory, at first glance—illustrates something special about this in-between place.

"When you look at conflicts in the world today, so many are centered on the Middle East and tensions that have been here for millennia," he said. "And then the Sinai becomes a very important symbol, because you have fervent Christians and very fervent Muslims, and we're divided by language, by religion, by culture, by so many things that make for conflict, and at the same time there's been this amazing harmony."

The key, he said, is simple: "I think there's a common reverence for Sinai as a holy mountain." Their common interest, that is, supersedes their differences.

Fourteen centuries ago Muhammad agreed. After his encounter with the monks here, he issued an oath of protection for "the Monks of Mount Sinai, and... Christians in general," a handwritten copy of which Justin keeps in the ancient library. Muhammad decreed that "whenever any one of the monks in his travels shall happen to settle upon any mountain, hill, village, or other habitable place, on the sea, or in deserts, or in any convent, church, or house of prayer, I shall be in the midst of them."

And further to the point: "No one shall bear arms against them, but, on the contrary, the Muslims shall wage war for them."

A radical young man—a dentist, of all things—decided in 2002 to form a terrorist group in Sinai. The details of his early work emerged only after questionable interrogations by Egyptian authorities, including alleged torture, but the story is familiar in its broad aspects: Khalid Al Masaid formed Tawhid wa Jihad—Unity and Holy War—to lash out against the United States and Israel,



Mediterranean Sea

Jerusalem

WEST BANK

GAZA STRIP

EL AHRASH

JANUARY 2008

ZARANIQ

El Arish

APRIL 2006

ISRAEL

NILE DELTA

Port Said

SUEZ CANAL

Suez

Springs of Moses

Fortress of Saladin

Sudr

Nakhl

SINAI

JORDAN

OCTOBER 2004

Taba

Elat

TABA

Ras Shaitan

OCTOBER 2004

Nuweiba

SAUDI ARABIA

ABU GALLUM

Wadi Feiran

St. Catherine's Monastery

Mt. Sinai
7,497 ft
2,285 m

APRIL 2006

Dahab

ST. CATHERINE

NABQ

El Tur

Nabq

Naama Bay

Sharm el Sheikh

JULY 2005

RAS MUHAMMAD NATIONAL PARK

RED SEA ISLANDS

- ▭ National park or other protected area
- 🔥 Terrorist attack or border breach
- Point of interest
- △ MFO base
- ⋯ MFO sector boundary
- Road

The Multinational Force and Observers (MFO) is responsible for supervising implementation of the 1979 peace treaty between Egypt and Israel.

0 mi 30
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JEROME N. COOKSON AND MARGUERITE B. HUNSIKER, NG STAFF

32° E

33°

34°

35°



RESORT TRASH offers recyclables to needy boys and food to Bedouin camels when pasture is scarce. A visitor (opposite) has a more sheltered view, including of the luxury Hilton Taba resort. Terrorists released their fury at the hotel's opulence and ethnic mixing in 2004 with an attack that killed 31. Bookings plunged but are rising again.

which he felt had humiliated the Arab world. Al Masaid regarded Egypt's 1979 peace deal with Israel as a collusion with the West. The deal led to the creation of the Multinational Force and Observers, an international team of peacekeepers who stifle movement along the Egypt-Israel border. To Al Masaid, the peacekeepers were more than an affront; they cut him off from possible Palestinian help. The dentist needed followers—disaffected young men willing to strike out against authorities, against tourists, against Israel, against Egypt itself. He found them among Sinai's own people.

Sinai's land bridge has offered passage for prophets and pilgrims, traders of goods and ideas. But like any bridge it also holds strategic value in war. Armies have marched across its dunes as long as men have fought: the

pharaohs with their chariots, the Persians, the Greeks, the Romans. The Islamic conquerors and their nemeses, the European crusaders. The Ottoman Turks and the British. All have carried the sands of Sinai on their soles.

The latest iteration of war, between the Egyptians and Israelis, shaped life on the peninsula today. It shaped the literal topography—bunkers and trenches still cross the horizon—but it shaped the human landscape in more unexpected ways. Although the current truce began 30 years ago, mainland Egyptians still often regard Bedouin, the desert herdsman who make up more than half of Sinai's 360,000 or so people, as collaborators with the enemy. The Bedouin simply showed no loyalty to any government, Egyptian or otherwise.

As I left Mount Sinai, a policeman directed me onto the roadside at one of Egypt's many police



checkpoints. A junior officer climbed into the backseat. He said he was “from Egypt,” which in Sinai meant he came from Cairo, and he wanted a ride across the peninsula. Such behavior is expected in Egypt, where the police are imbued with universal power. But something more surprising happened as we drove past a water pipeline the Egyptian authorities were laying through Sinai, as part of an effort Sinai dwellers call the “Cairo-fication” of the peninsula.

“Never stop to pick them up,” the policeman said, indicating a family of Bedouin with their goats. He shook his head in the rearview mirror. “They are treacherous. They are not human.”

Unlike people in many other Arabic countries who revere the Bedouin—consider Saudi royals swaying in a traditional Bedouin sword dance or Libya’s leader pitching a tent during a state visit in Paris—Egyptians have never embraced desert-dwelling tribes. The Bedouin migrated from the east; the Nile inhabitants came from the west. The Bedouin historically roamed vast territories, but Nile

culture is agrarian, respectful of cultivation and stillness, and suspicious of nomadic wandering.

In the 1970s, after Israel took over Sinai following the Six Day War, its government—also uncomfortable with paperless, border-defying citizens—pinned down the Bedouin with jobs, paying them to manage Sinai’s vast nature reserves, among other things.

In Israel I had met with Dan Harari, who worked as a bureaucrat governing southern Sinai during Israel’s administration. In his home office was a photo of him sitting at an unlikely desk planted in the desert, signing checks for a line of tribesmen that extended beyond the frame. “We knew we couldn’t control the Bedouin,” he said, “so we just used their knowledge of the place.” It worked, he said, telling stories about a Bedouin man he “loved like a brother.” After Israel fully ceded control of Sinai in 1982, the Egyptian government dismantled the Bedouin program and formed the Tourism Development Authority, designed to stake a claim on valuable land.

Near a freshwater spring in the Sinai mountains,



IN AN ENCLAVE OF TOLERANCE, beachgoers from worlds apart coexist near Sharm el Sheikh. This coast has been consumed by development since 1982, when Egypt last assumed control of the region. The country has built the world's largest tourism police force to protect this vital industry.



Egyptians have never embraced desert-dwelling tribes. Nile culture is agrarian, suspicious of nomadic wandering.



I spoke with a tiny, elderly Bedouin woman named Sheikha Salima, who estimated her age as 70 or 80, maybe more. She looks back on the peninsula's alternating conquerors much as she does the alternating striations in the cliffs surrounding her goat-hair tent: They merely mark the fickle passage of time. "It was better when the Israelis were here," she said, shaking a bead-strung fist in defiance, not at an abstract Cairene power but at the junior police officer just a few feet away. "They have destroyed our customs,"

she shouted with the bravery of untouchable old age. Her veil fluttered before her puffed breath. "They have pushed us from our land."

Her well was almost dry, and goat droppings carpeted the floor of her home. In the old, migratory days she might have moved on during the difficult season. Now she had nowhere to go.

The policeman shrank from the Bedouin woman's wrath. He understood what she meant about the land. And he knew too well just how explosive such anger could prove.



SIMPLE BREAD called *feteer* helps feed Bedouin families in a squatters' camp near Naama Bay. Drought has pushed tribes down from the mountains to seek work, but deep-rooted distrust by Egyptian bosses keeps many of the men jobless and families suffering.

Deep in the desert in the spring of 2004, a group of men gathered with a peculiar set of equipment. They carried mobile phones, washing machine timers, gas cylinders, and TNT. The explosives came from the desert, where they had been discarded following the easing of tensions with Israel. A religious extremist named Iyad Salah—a follower of the dentist Al Masaid—had recruited this small group, which included a day laborer, an appliance repairman, and a metalworker. Others were jobless, and most came from a town called El Arish, on the Mediterranean at Sinai's northern edge. Among the dunes the men rehearsed their plot, setting off explosives in the sand.

Whomp.

Whomp.

WHOMP.

The pair of near-naked women onstage found the bass beat as the disc jockey tweaked the volume, and the huge screen behind them showed two cherries quivering on stems. Above the crowd two other women twirled and dangled on elongated silk sheets, hardly noticed by 2,000 young people dancing below. An air of expectation filled the club called Pacha, expectation mingled with liquor and deodorant, and everyone watched a duct overhead until—yes, at last—it gushed bubbles and white foam. From somewhere, everywhere, young people appeared in bathing suits and underwear, leaping into the foam and then splashing into the club's pool.

"Where did you get the dancing girls?" I asked Adly El Mestekawy, the club's owner. "They're not Egyptian."

El Mestekawy laughed, moving to the beat. "Russia," he said.

After Egypt last resumed control of the Sinai, businessmen from the Nile Delta developed its coastline with remarkable speed, importing Cairene values, workers, materials, rhythms. The peninsula boasts some of the finest dive sites in the world, luring young tourists from Europe and beyond. Bedouin grazing grounds gave way to international hotels, clubs, shops, bars. Traditional culture bowed to glitz. The Sinai fractured, with a schism between



AGE-OLD TRUST and mutual reliance endure in St. Catherine's Monastery, where Bedouin Salam Hussein (above, seated at right) and his chief have come for advice from Greek Orthodox Archbishop Damianos (far left). On a peak above the monastery (opposite), wind whips German travelers at the Chapel of the Holy Trinity, built and rebuilt over 16 centuries.

coast and inland that may as well have split the Earth's crust.

El Mestekawy, a Cairo native, pioneered the development in Sharm el Sheikh, near the peninsula's southern tip. In his office, away from the thump of the dance floor, he unfurled a colossal photo of the town 20 years ago—except there was no town. The photo showed only a squat gray building, a few tents, the sea, and endless desert. “There we are,” he said, pointing to the gray lump. It started as a hotel and later became a nightclub. “Otherwise just the Bedouin.”

Where are they now? I asked.

He waved a hand west. “The hills,” he said.

Along the boulevards outside the club, thousands of tourists flocked beneath electric palm trees, sipping mango smoothies and wearing sunglasses at midnight. The only Egyptians in sight served drinks and gave out flyers. They were the

lucky ones who held work permits that allowed them past the checkpoints outside the city.

The next day the scene on the beach might have been Ibiza or St.-Tropez, except for the rarest reminder that we were indeed in the Middle East: Topless sunbathers strained to ignore the lone figure in a full black *niqab*, sitting like a slab of onyx while her husband splashed in the surf.

El Mestekawy's assistant, Timi, drove me in his boss's sport-utility vehicle to see his next business venture. As we rounded a bend on the coast, an enormous sand castle loomed. “Biggest in the world,” Timi said. When it's finished, he explained, it will serve as a marine playground, with an aquarium, water park, and restaurants.

We climbed the castle, dodging workers from Cairo who were building the structure, which wasn't made of sand but from chunks of




fossilized coral. At the top we overlooked the Red Sea with its treasures: a thousand species of fish, coral reefs, mangroves. This beautiful, fragile underwater ecosystem started the boom, and now, remarkably, Sinai has overtaken Cairo and the mainland as Egypt's top tourism destination. The population of Sharm el Sheikh has leaped tenfold in 20 years, while the number of tourists has gone from 8,000 a year to more than five million.

When Egypt took over control of the Sinai, the state—eager to stamp the territory as its own—bulldozed Bedouin camps and homes to make way for wealthy mainland investors. One hundred percent of Sharm el Sheikh's coastline now belongs to developers. Bedouin tribe members believed in a principle called *wadaa al-yad*—literally, “put your hands”—by which a man owns land when he improves it with irrigation, for instance, or trees. So some Bedouin laid concrete foundations beside their homes, hoping the nod to permanence might impress the state and save their property. But the government bulldozed those as well.

One powerful Bedouin tribal leader, Sheikh Ishaysh, refused to abandon his camp on the coast north of Sharm el Sheikh in a village called Nuweiba. “They came with a rich man who said he had bought my land,” he said. The sheikh shook his head—the rich man had dug no wells and planted no trees. “I told them, ‘I will die here.’” Sheikh Ishaysh stared down the developers, but many of his compatriots simply gave up and moved inland.

Meanwhile the Cairo-fication reached beyond cement and pipes. Few scholars have studied the Sinai Bedouin closely, but Clinton Bailey, a respected anthropologist, has spent four decades among the tribes. His assessment is bleak. “In the 1970s there were many poets composing traditional poems with contemporary content. Today there isn't even one worthy of the name poet,” he said. “Daughters are no longer taught to weave carpets and tent curtains. Young men know less and less about the relationship between tribes or sections of tribes. The diet is no longer traditional. Very few still know tribal stories and histories.”



DESCENDING MOUNT SINAI, a Bedouin boy and his donkey return from carrying supplies to tribal-run shops on the trails above. Biblical Israelites wandered here on their way to the Promised Land. Today, historical sites and natural beauty make Sinai a destination in itself.



Deep in the desert a group of men gathered with mobile phones, washing machine timers, gas cylinders, and TNT.

Reaching El Arish, home of most of the men who rehearsed their plan in the desert, isn't easy. All roads connecting south Sinai to the north are considered "security roads" and off-limits to visitors. I bypassed them by driving up the west side of the peninsula, giving Cairo as my destination at police checkpoints, joining a line to ride a ferry across the Suez Canal to the capital, then instead veering away toward the Mediterranean coast.

The north feels separate in more ways than bureaucratic; even the landscape bears no resemblance to the high, pink mountains of the south. Sand dunes roll into the distance, reclaiming roadways and stretching all perspective at eye level. Everything seems far away in northern Sinai.

The Egyptian government once saw much promise in the north coast. A generation ago El Arish shone like a jewel on the Mediterranean, with wide beaches and rows of palm trees that produced fleshy dates. The city received the state's favor, and good schools grew up among resorts and businesses. Geographically El Arish is better suited than the south for touristic development, with its flat topography easing into sandy beaches and shallow seas, rather than steep mountains crashing down to coral reef.

But two decades ago the explosion of southern development drew all resources away from the north. And unrest in Gaza, just 30 miles away, drove out the last foreign tourists.

Entering El Arish now feels like attending a spooked dinner party, with plates of half-finished food and empty chairs where the guests should be. I passed a shuttered tourism office and a boulevard of abandoned resorts that faced the Mediterranean. In the city center young men stood on sidewalks, gazing into the streets, as though perpetually awaiting something. According to one study, more than nine out of ten people age 20 to 30 have no full-time job, much less any hope of obtaining a work permit for resorts in the south.

After a short time in El Arish, following weeks elsewhere in Egypt, something felt out of place: There seemed to be no women. In other parts

of Sinai any social divisions relate to class and tradition, not religion, and women appear in public as often as men. But El Arish has drifted into a brand of Islamic conservatism that keeps women mostly at home and almost always covered. This is the environment in which Iyad Salah recruited his Bedouin conspirators, including the Flayfil brothers, Muhammad and Suleiman.

I found the Flayfil home in a poor village on the outskirts of El Arish. A boy ran to bring out elderly Sheikh Ahmed Flayfil, who blinked as he entered the sun-blached courtyard. He did not sit or pour tea, which broke all Bedouin protocol. After a long look, he asked, "Are you here to ask about my dead sons?"

I was.

The sheikh sighed and stared out toward the never ending dunes. People in town talked about how his sons had grown long beards and retreated to the desert for their prayers instead of joining their neighbors in the mosque. The sheikh had disowned his sons.

At last he said, "They died."

And he withdrew with no further word.

There were two other bombs that October evening. In Nuweiba, Asser El Badrawy stood on the balcony of his hotel, looking north along the coast toward a backpackers' camp. That's when he saw a great blast rise from the campground. Moments passed, and the sound of the explosion arrived; below, his guests on the beach—almost all Israeli—turned to see a small mushroom cloud forming over the blast site. A nuclear bomb, El Badrawy thought. The Sinai enjoyed a reputation as a peaceful place, so the sight of the cloud made no sense. And in the irrationality of the moment he ran to his bathroom and hid, waiting for a blast wave that didn't arrive.

On the road outside the camp, a man in a car had tried to drive in but had been startled at the last moment by the appearance of a guard with a lantern. He hastily backed up the car and got stuck in a sand dune. Then he walked away and detonated the car by remote control. At a nearby camp, another driver parked near

a palm-roofed restaurant and exploded his car, destroying the restaurant and several bamboo huts. The blast killed two Israelis and a Bedouin. Again the driver walked away unseen.

The third target was the Hilton, farther north at the Israeli border. The two men in the vehicle that pulled up to the lobby—the leader, Salah, and laborer Suleiman Flayfil—could have been anyone: new guests arriving, staff workers, deliverymen. Inside the hotel hundreds of guests danced, ate, or slept. Salah and Flayfil parked and walked away. Inside the vehicle a TNT package was wired to a washing machine timer, which clicked away its final seconds. The vehicle exploded with tremendous force, collapsing the entire western side of the hotel, sending ten stories and their contents sliding like an avalanche toward the ground. Cars in the parking lot were tossed aside and burst into flames. Glass shards and furniture flew in all directions; concrete spiral staircases lay strewn about.

The bomb killed 31 people and injured many more, including Israelis, Egyptians, Russians. It also killed Salah and Flayfil; their timer had gone off too soon, and the blast caught them before they left the hotel grounds. The Egyptian government responded with its peculiar form of investigation, rounding up thousands of suspects—figures vary from 2,400 to 5,000—including many Bedouin from the El Arish area.

Ten months after the bombing, the surviving Flayfil brother, Muhammad, died in a shootout with police. Three other Bedouin suspects—Younes Mohammed Mahmoud, Osama Al Nakhlawi, and Mohammed Jaz Sabbah—were eventually caught and sentenced to death by state security courts, with no right of appeal.

Near El Arish, in the same mud-brick village where the Flayfils' father had disowned them, I met with the parents of Osama Al Nakhlawi in their small, clean home. They sat on the floor in a simple room and served tea. They spoke quietly but wrung their hands, sometimes their own, sometimes one another's.

"Anyone they suspected, they picked up," Al Nakhlawi's mother said. Egyptian police say her son built the bombs. She unfolded a recent

handwritten letter from him, already so well worn that it flopped like cloth in her hands. In it he deplored the treatment of his Bedouin tribe.

"We the children of Sinai," he wrote from death row, "are dealt with in a racist and discriminatory manner in comparison to the children of the Nile Valley.... Some of the officers accuse us of being loyal to the Jews, and at the same time they are trying us on the basis of killing Jews."

Many in El Arish contend the government's heavy-handed reaction to the bombing only further divided the population, as the bombers had intended. And indeed, in 2005 more bombers struck the Sinai at Sharm el Sheikh, killing scores of people on Egypt's Revolution Day: a clear assault on the Egyptian authorities rather than Israel. Al Masaid, the group's dentist founder, died in a gunfight with Egyptian police, but, authorities say, his followers struck again during the spring holiday of 2006, at the resort town of Dahab, killing at least 23 people.

All this might have been desired, and even predicted, by the Hilton resort bombers in Taba. There was, however, another, unintended consequence.

As Israel's chief developer of southern Sinai during its time there, Dan Harari, the bureaucrat who issued Bedouin paychecks, had signed permits for the construction of the Hilton Taba. He knew it well. After the Israeli pullout of 1982, Harari had found a new job across the border in Eilat. He worked as the fire chief.

The night of October 7, when he heard the blast, he changed clothes in his car, shedding his casual holiday wear and pulling on his wrinkled gray uniform shirt. As the town's three fire trucks and the off-duty firefighter, Shachar Zaid, arrived, he climbed aboard the lead truck and turned on its siren. "I saw the people. I saw the smoke," he said. "I knew there were people I needed to save."

The Egyptian guards at the border crossing stood with their automatic weapons, ready to fire. From their perspective, it seemed the whole

Thousands of tourists flocked under electric palm trees, sipping mango smoothies and wearing sunglasses at midnight.



world had turned inside out. The nearby hotel lay in ruins, wailing masses of people were converging on their position, and now a battery of enormous trucks had arrived, piloted by their age-old enemies. After a brief hesitation—questions and answers shouted across that invisible line—the Egyptian soldiers made a momentous decision: Suspending their country's sovereignty, they withdrew their weapons and stepped aside so the fire trucks could enter.

At the site of the disaster, the Israeli firefighters

worked alongside their Arab counterparts to put out the fire and pull bodies from the wreckage. The rescuers discovered that a main source of water for the fire trucks, the hotel's seawater swimming pool, was empty, so the work was fiery and slow.

The Israelis and Egyptians—both victims and saviors—seemed more alike than apart in those hours. The rescue workers shared food and water—a gesture that in the Middle East carried resounding symbolism. Israeli Prime Minister



WHIRLING atop a café overlooking Naama Bay's pedestrian boulevard, a tambourine-shaking Sufi dancer seeks to approach the divine—and attract diners. Despite the threat of terrorist attacks, Sinai's open arms and modern aspirations will persist, as long as the tourists keep coming.

Ariel Sharon lauded Egyptian President Hosni Mubarak for his country's cooperation, and both leaders vowed to "continue cooperation in the ongoing struggle against terror."

The Egyptian government, characteristically, is now applying sheer authoritarian might. Distrustful policemen and soldiers from Cairo blanket the peninsula, seeming to appear wherever two roads intersect, wherever two people meet, vigilant to keep Sinai locals and foreigners apart. But others are urging a softer path. The International Crisis Group, a leading nonprofit agency focused on conflict, issued a report in 2007 that called for the Egyptian state to "alter a development strategy that is deeply discriminatory and largely ineffective at meeting local needs." Clinton Bailey, the Bedouin expert, says the government should heed an ancient Bedouin proverb: "If you muzzle a hawk, you must feed him."

And the visitors have been returning. The day of the Taba bombings there were as many as 15,000 Israelis on the peninsula. The numbers dropped sharply after that, but the day I arrived in Sinai, during the 2007 Passover holiday, 1,700 Israelis crossed the border to visit.

People in Sinai have always blended in unexpected ways, whether on a sacred mountaintop or in camps on the beach. The Hilton Taba terrorists tried to take advantage of this mingling: With one bomb they could attack the Westerners who ran it, the Egyptians who worked there, and the Israelis who visited. But their plan went astray in one sense; their bomb, to some degree, fused those disparate groups into one injured people, as the victims pulled together to salvage lives after the disaster.

Every act of trust in the Middle East is relative. But like the monks and the Bedouin on Mount Sinai, the people in Taba had common interests—if only dancing in a hotel disco—and so made themselves some measure less vulnerable to the dividing power of terrorism.

That was why firefighter Shachar Zaid crossed one of history's most disputed borders to work alongside Egyptian counterparts. "That was our way to tell the terrorists, You did not succeed," he said. "And they did not succeed." □



The New World's biggest cat won't survive in isolated, protected habitats. It needs safe migration corridors so it can move and breed. "If we write off these in-between areas," says conservationist Alan Rabinowitz, "we write off our best chance to keep jaguars from going extinct."



BY MEL WHITE

**IF FORWARD-LOOKING
CONSERVATIONISTS
PREVAIL, THIS WANDERER
WILL LIVE ON.**

PATH OF THE JAGUAR

AT DUSK ONE EVENING, deep in a Costa Rican forest, a young male jaguar rises from his sleep, stretches, and silently but determinedly leaves forever the place where he was born.

There's shelter here, and plenty of brocket deer, peccaries, and agoutis for food. He has sensed, too, the presence of females with which he might mate. But there's also a mature male jaguar that claims the forest—and the females. The older cat will tolerate no rivals. The breeze-blown scent of the young male's mother, so comforting to him when he was a cub, no longer binds him to his home. So he goes.

But the wanderer has chosen the wrong direction. In just a few miles he reaches the edge of the forest; beyond lies a coffee plantation. Pushed by instinct and necessity, he keeps moving, staying in the trees along fences and streams. Soon, though, shelter consists only of scattered patches of shrubs and a few trees, where he can find nothing to eat. He's now in a land of cattle ranches, and one night his hunger and the smell of a newborn calf overcome his

PETE OXFORD, MINDEN PICTURES

Powerful in the water, jaguars often travel along streams, hunting peccaries and brocket deer as they go, leaving few traces of their passage. That can make tracking these cats a challenge for Rabinowitz and his team (opposite, in Costa Rica). They work like detectives, seeking hard evidence of where jaguars have been, and interviewing locals who may have spotted one.



reluctance to cross open areas. Creeping close before a final rush, he instantly kills the calf with one snap of his powerful jaws.

The next day the rancher finds the remains and the telltale tracks of a jaguar. He calls some of his neighbors and gathers a pack of dogs. The hunters find the young male, but they're armed only with shotguns; anxious, they shoot from too great a distance. The jaguar's massively thick skull protects him from death, but the pellets blind him in one eye and shatter his left foreleg.

Crippled now, unable to find his normal prey in the scrubby forest, let alone stalk and kill it, he's driven by hunger to easier meals. He kills another calf on an adjacent ranch, and then a dog on the outskirts of a nearby town. This time, though, he lingers too long. Attracted by the dog's howls, a group of villagers tree him and,

though it takes many blasts, kill him. Jaguars, they say, are nothing but cattle killers, dog killers. They are vermin. They should be shot on sight, anytime, anywhere.

This sad story has been played out thousands of times throughout the jaguar's homeland, stretching from Mexico (and formerly the United States) to Argentina. In recent decades it's happened with even greater frequency, as ranching, farming, and development have eaten up half the big cat's prime habitat, and as humans have decimated its natural prey in many areas of remaining forest.

ALAN RABINOWITZ ENVISIONS a different ending to the story. He imagines that the young jaguar, when he leaves his birthplace, will pass unseen by humans through a near-continuous corridor of sheltering vegetation. Within a couple of days he'll find a small tract of forest harboring enough prey for him to stop and rest a day or two before resuming his trek. Eventually he'll reach a national park or wildlife preserve

Mel White is a regular contributor. Among his stories: Borneo in the November 2008 issue and the case of the ivory-billed woodpecker in December 2006.



**PASEO DEL JAGUAR IS
THE BEST HOPE
FOR KEEPING JAGUARS
FROM JOINING LIONS
AND TIGERS ON THE
ENDANGERED
SPECIES LIST.**

where he'll find a home, room to roam, plenty of prey, females looking for a mate.

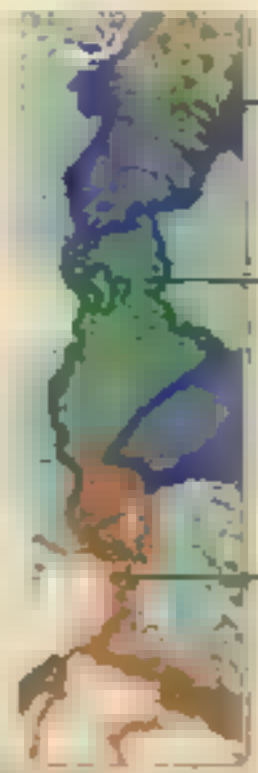
Rabinowitz is the world's leading jaguar expert, and he has begun to realize his dream of creating a vast network of interconnected corridors and refuges extending from the U.S.-Mexico border into South America. It is known as Paseo del Jaguar—Path of the Jaguar. Rabinowitz considers such a network the best hope for keeping this great New World cat from joining lions and tigers on the endangered species list.

Rabinowitz began his work with the Wildlife Conservation Society and now heads the Panthera Foundation, a conservation group dedicated to protecting the world's 36 species of wild cats. The foundation's current work represents a radical change in Rabinowitz's conservation philosophy from just a decade ago. In the 1990s, having censused jaguars across their range, Rabinowitz and other specialists identified dozens of what they called jaguar conservation units (JCU): large areas with perhaps 50 jaguars, where the local population was either

stable or increasing. At the heart of most of the JCUs were existing parks or other protected areas, which Rabinowitz hoped to expand and secure with surrounding buffer zones. "I felt that the best thing we could hope to do was to lock up these great populations in these fragmented areas," he said.

Within a few years, though, the new science of DNA fingerprinting—studying genetic material to determine family and species relationships—revealed an amazing fact: The jaguar is the only large, wide-ranging carnivore in the world with no subspecies. Simply put, this means that for millennia jaguars have been

RANGE OF THE JAGUAR



Known populations in purple

Corridors between population groups in green

Corridors most threatened by habitat loss in orange

LAND COVER



Barren

Forest

Grass



PRESERVING THE PATH

The discovery that jaguars from Mexico to Argentina are genetically a single species, not a collection of subspecies as once thought, launched the ambitious conservation strategy called Paseo del Jaguar—Path of the Jaguar. Even with relentless habitat loss, the threatened cats are finding routes to spread their genes among far-flung populations. The multinational project aims to identify and sustain or restore those connecting corridors, not necessarily by setting them aside as parks, but by persuading local governments to make jaguar-friendly development choices.

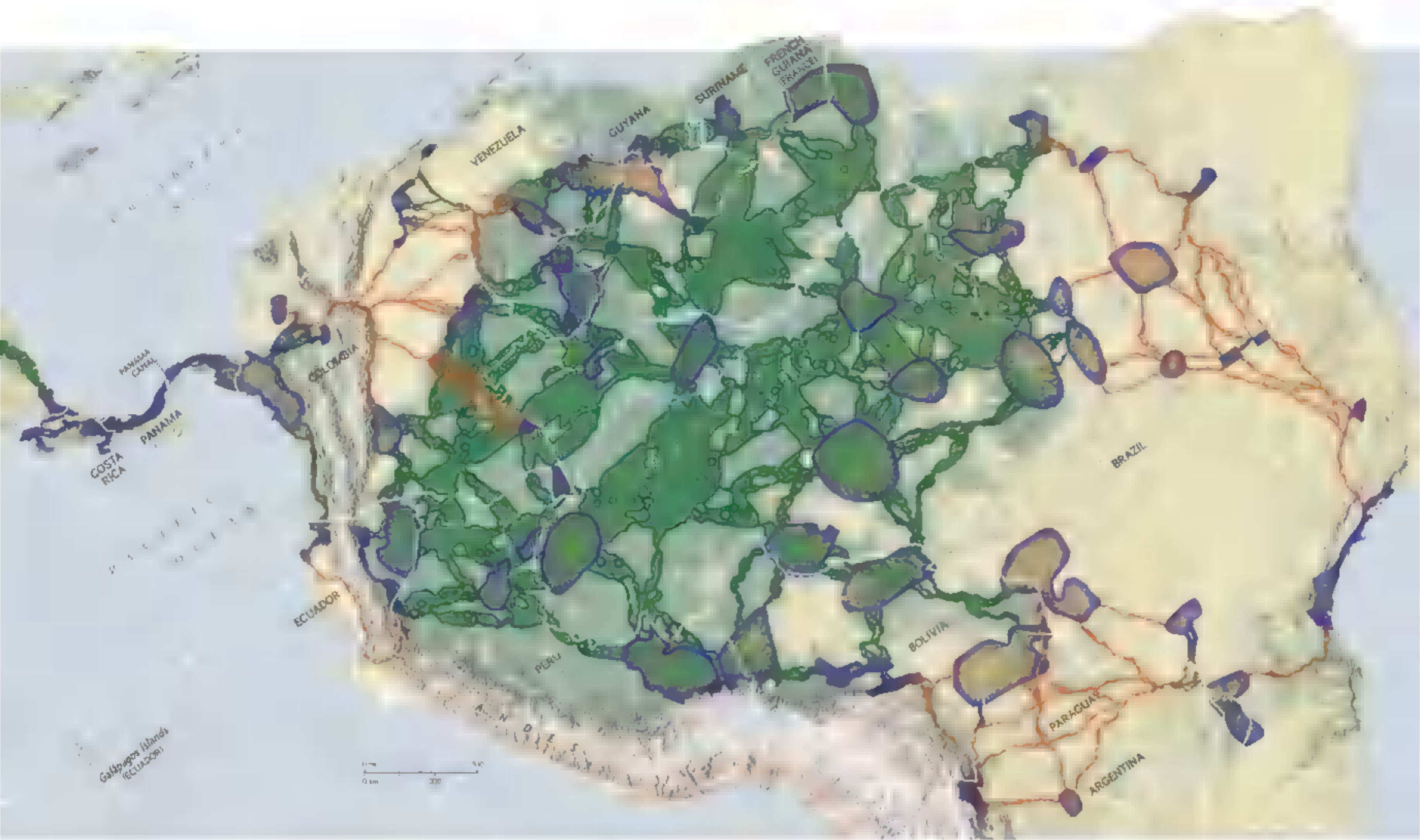


■ Historic range of the jaguar

JAGUAR POPULATIONS

The total number of these secretive cats is estimated to be at least 10,000. Researchers have identified 90 areas as jaguar conservation units, where perhaps 50 or more cats live and breed. Eleven of the areas have the potential to hold populations greater than 500.





WEB OF CONNECTIONS

The likely routes jaguars use to move between population groups form a web of 188 corridors stretching through 18 countries. The corridors mapped using observations of local experts and habitat data, are now being verified and refined by field research and satellite imagery.



CORRIDORS OF CONCERN

Jaguars prefer to travel in dense forest or, in a pinch, through farmland with suitable cover. Only thin ribbons of such habitat still exist between some jaguar population groups, threatening to isolate the cats geographically—and genetically.

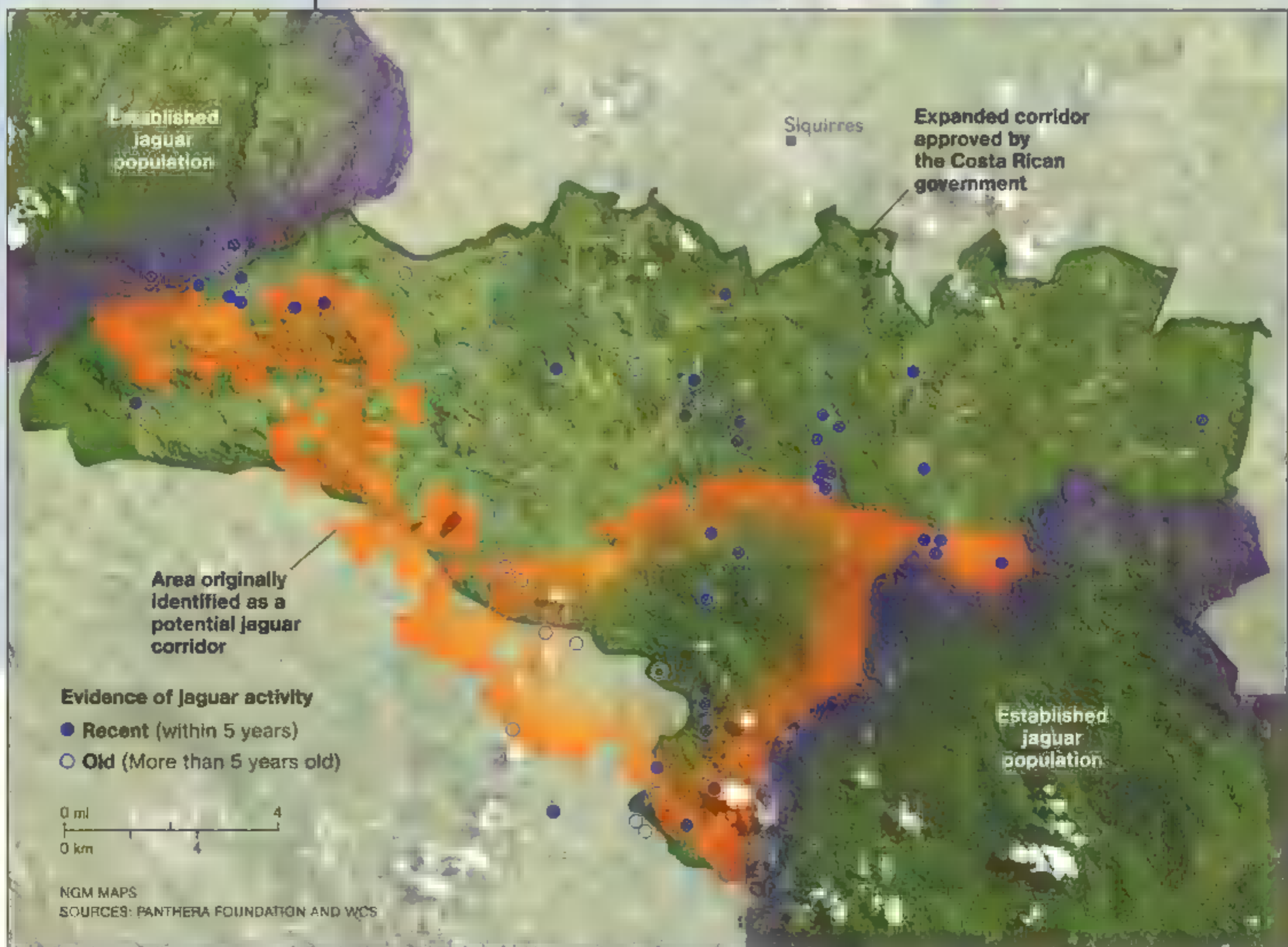




The vision of hungry cats prowling at the forest's edge, close to livestock and people, hasn't scared off supporters of jaguar corridors. "Most of the time, jaguars are no problem," says Rebinowitz. People in communities that support a corridor will receive incentives such as health care and scholarships.

FOCUS ON A VITAL LINK

Jaguars are known to swim across the Panama Canal, but there are potential barriers to cats wandering along the Central American land bridge. In Costa Rica, Paseo researchers fine-tuned their knowledge of territory identified as a corridor of concern (map below, in orange). Detailed satellite images revealed that the most viable habitat actually lay north of the original corridor. Tracks and other evidence of jaguar activity, along with reports from locals, confirmed the presence of cats. The Paseo team proposed an expanded corridor, where development will be balanced with jaguar needs, and the Costa Rican government agreed. Once field researchers refine other Central American corridors, work on South America's vast habitat network awaits.





**THEY SAY JAGUARS
ARE NOTHING
BUT CATTLE KILLERS,
DOG KILLERS.
THEY SHOULD BE
SHOT ON
SIGHT.**

mingling their genes throughout their entire range, so that individuals in northern Mexico are identical to those in southern Brazil. For that to be true, some of the cats must wander regularly and widely between populations.

Rabinowitz and his colleagues went back to their data to see whether the preserves could still be linked with habitat adequate to support a traveling jaguar. “Lo and behold,” Rabinowitz said, “while good jaguar habitat, where the cats can live and breed, has decreased by 50 percent since the 1900s, habitat a jaguar can use to travel through has decreased only by 16 percent. Most of it is intact and contiguous. These

places are like little oases—very small patches that jaguars will come to, use while, and then leave. We were writing these places off because they’re not habitat where a permanent jaguar population can live. Now they’re turning out to be crucial.”

Rabinowitz hopes to convince national governments throughout the jaguar’s range to maintain this web of habitat through enlightened land-use planning, such as choosing non-critical areas for major developments and road construction. “We’re not going to ask them to throw people off their land or to make new national parks,” he said. The habitat matrix could encompass woodlands used for a variety of human activities from timber harvest to citrus plantations. Studies have shown that areas smaller than one and a half square miles can serve as temporary, one- or two-day homes—stepping-stones—for wandering jaguars.

While the habitat making up the proposed network is mostly intact for now, prompt conservation action will be needed to protect it,



Loping along a road in Guyana, a jaguar has the law on its side. A 1975 international ban on trade in jaguar pelts dramatically reduced poaching, but as skins confiscated in Mexico (opposite) show, killings have continued. “We can’t stop all poaching,” says Rabinowitz. “I’m looking for stability.”

especially in certain areas of Central America and Colombia, where some jaguar travel paths already are critically tenuous. By studying satellite photographs and airplane surveys, and walking sections of the proposed corridor to follow up on reports from local people, Rabinowitz and his team can identify the segments most in need of protection. He then can go to government decision-makers with hard scientific data, he said. “Our first challenge is looking at corridors where there’s just a single tendril. We’ve got to lock up these areas.”

Diana Hadley of the Arizona-based Northern Jaguar Project works to protect the northernmost jaguar population in Mexico, with the long-term goal of seeing the species return to the United States. Hadley said the project and its Mexican partners “fully support” Paseo del Jaguar. “If these magnificent animals are ever to reoccupy appropriate habitat north of the border,” she said, “the stepping-stones in the jaguar corridor are essential.”

Paseo del Jaguar ranks with the world’s most

ambitious conservation programs, and realizing it will take many years. Rabinowitz is focusing first on Mexico and Central America, where officials in all eight countries have approved the project. Costa Rica has already incorporated protection of the corridor into laws regulating development.

Later he’ll tackle South America, where landscapes and political situations are more diverse and challenging. Rabinowitz is encouraged, though, by his audiences’ emotional response when he talks about jaguars—a response based on the animal’s enduring aura of beauty, strength, and mystery. Indigenous peoples around Mexico’s central plateau, and the Maya, farther south, incorporated the jaguar into their art and mythology. Today even mobile-phone-carrying government ministers sitting in urban offices feel what Rabinowitz calls “a powerful cultural thread binding them to their ancestors. Nobody can say that the jaguar is not part of their own heritage,” he said. “What better unifying symbol can there be than the jaguar?” □

STILL

OFF THE SHORES OF COSTA RICA, SCIENTISTS STUDY A STRONGHOLD
OF WHALES THAT ONCE HOVERED NEAR EXTINCTION.

BLUE







Even as a baby, a blue whale can make a grown man seem like a minnow. Decades ago, with their numbers plummeting, this species became a symbol of environmental woes. Now such healthy youngsters offer hope that the giants can be saved.

Taking the lead in a heaving September sea, whale researcher Bruce Mate prepares to fire off a satellite tag designed to track his target's autumn journey south from California. Behind him, volunteer Al Goudy aims a biopsy dart.



By **KENNETH BROWER**

Photographs by **FLIP NICKLIN**



In Acapulco Harbor, amid the white yachts, R.V. *Pacific Storm* stood out: a working boat, black hulled, a West Coast trawler in a previous life, reborn now as a research vessel. There were bigger, more opulent boats in the harbor—fortunes are invested in the white yachts of Acapulco—but this 85-foot trawler, with its grim mien and high black bow, was the ship for me. Asked to choose, from all this fleet, the vessel to carry me on a month-long cruise in pursuit of blue whales, I would not have hesitated. As Flip Nicklin and I passed our gear up the trawler's ladder and stowed it in our cabin, I felt an almost savage contentment.

Call me Ishmael, if you like, but whenever I find myself growing grim about the mouth; whenever it is a damp, drizzly November in my soul; whenever I have spent too many consecutive months at the computer keyboard, in artificial light, like some sort of troglodyte, self-imprisoned, pecking out my living, I account it high time to get to sea as soon as I can. I jumped at the assignment on *Pacific Storm*. As the voyage was to depart on the third of January, I made three New Year's resolutions: I would try to be an affable shipmate. I would strip all the blubber from my prose. I would refrain from making a single allusion to Herman Melville.

Did I mention we were after a white whale?

It's true. In the eastern North Pacific population of blue whales—the group that summers mostly off California and whose migration we were following south—there is a white blue whale, maybe an albino. An inflatable skiff from *Pacific Storm* had satellite tagged this whale off Santa Barbara four months before, but his tag, number 4172, had ceased transmitting a few weeks after implantation, and now his whereabouts were a mystery. The sun-synchronous, polar-orbiting TIROS N satellites could no longer track him, but he was one of the animals we hoped to see off Central America.

Ken Brower writes on the natural world and lives in Berkeley, California. Flip Nicklin, a leading whale photographer, lives in Juneau, Alaska.

When we had settled in on *Pacific Storm*, Nicklin, cross-legged on his bunk, set up his Nikon D200, with its Sea & Sea underwater dome. He squeezed a dab of silicone grease from a small tube onto his fingertip and ran it around the rim of the dome's blue O-ring. He opened the back of the camera and gave a similar treatment to the O-ring at the stern. Nicklin is a new kind of whaler. His job is not to render the oil, but to capture the essence of cetaceans, and the Nikon is his favorite harpoon.

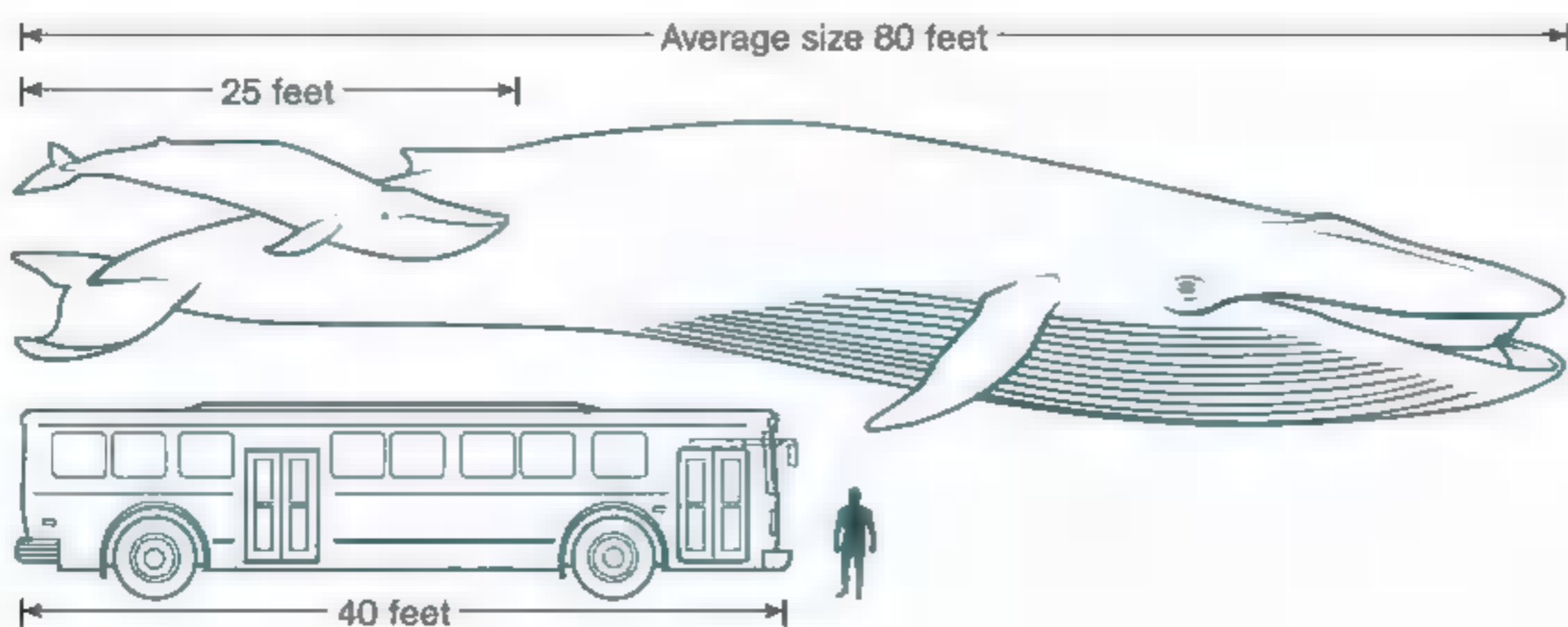
Pacific Storm put to sea. We sailed a leg due south to avoid the Tehuantepec winds along the eastward bend of Central America, then turned southwest toward the temperature anomaly that was our destination.

The Costa Rica Dome is an upwelling of cold, nutrient-rich water generated by a meeting of winds and currents west of Central America. The location is not fixed; it meanders a bit, but the dome is reliably encountered somewhere between 300 and 500 miles offshore. The upwelling brings the thermocline—the boundary layer between deep, cold water and the warm water of the surface—up as high as 30 feet from the top. Upwelling with the cold, oxygen-poor water from the depths come nitrate, phosphate, silicate, and other nutrients. This manna, or anti-manna—a gift not from heaven but from the deep—makes for an oasis in the sea. The upwelling nutrients of the dome fertilize the tiny plants of the phytoplankton, which

feed the tiny animals of the zooplankton, which bring bigger animals, some of which are very big indeed.

The blue whale, *Balaenoptera musculus*, is the largest creature ever to live. Linnaeus derived the genus name from the Latin *balaena*, “whale,” and the Greek *pteron*, “fin” or “wing.” His species name, *musculus*, is the diminutive of the Latin *mus*, “mouse”—apparently a Linnaean joke. The “little mouse whale” can grow to 200 tons and 100 feet long. A single little mouse whale weighs as much as the entire National Football League. Just as an elephant might pick up a little mouse in its trunk, so the elephant, in its turn, might be taken up by a blue whale and carried along on the colossal tongue. Had Jonah been injected intravenously, instead of swallowed, he could have swum the arterial vessels of this whale, boosted along every ten seconds or so by the slow, godlike pulse.

The great swimming speed of the blue whale, together with the remoteness of its stronghold—where three of Earth's oceans merge in the ice-cold waters around Antarctica—protected most of the species until early in the 20th century. With the invention of explosive harpoons and fast, steam-powered catcher boats, the stronghold was breached. Through the first six decades of the 20th century 360,000 blue whales were killed. The population around South Georgia Island was extirpated, along with those that once fed in the coastal waters of Japan. Some



EXTREME MEASURES

At birth a blue whale averages 25 feet and weighs about three tons. Feeding only on its mother's milk, which is 40 percent fat, a calf gains nine pounds an hour. As an adult, it may easily stretch to twice the length of a city bus and weigh close to 200 tons.

blue whale populations were reduced by ninety-nine one-hundredths, and the species tipped at the very brink of extinction.

For Bruce Mate and John Calambokidis, the head scientists aboard *Pacific Storm*, the irony is deep and poignant. The blue whales they study, the 2,000 animals that summer off western North America, once just a splinter group, now make up a significant population.

Mate, director of the Marine Mammal Institute at Oregon State University, is the world's most inventive and prolific satellite-tagger of whales. The dome first caught his attention in 1995, when a blue whale he had tagged off California in summer began transmitting from off Costa Rica in winter. Calambokidis, a co-founder of Cascadia Research, in Olympia, Washington, is the West Coast's most prolific photo-identifier of whales. A tall, lean biologist with a Quaker seaman's beard and monomaniacal dedication to bringing back diagnostic images, Calambokidis was tantalized by the reports from the satellite. In 1999 he made a reconnaissance of the dome by sailboat. The voyage was plagued by bad weather, and the sailboat was too small for its mission, yet at the dome Calambokidis managed to photo identify ten whales that he had photographed off California.

Why would a blue whale depart its feeding grounds at the end of summer and migrate thousands of miles to spend winter in this tropical zone of upwelling? Mate and Calambokidis thought they knew. The satellite data showed that some of the tagged whales lingered five months or more at the dome, arriving early in the southern migration and departing late—a pattern that, in other species of baleen whales, is seen in pregnant females and new mothers. It had never been noted in blue whales, for the best of reasons: No one has ever witnessed the birth of a blue whale.

Gray, humpback, and right whales—the baleen species that have been studied at their calving grounds—seem to feed little, if at all, at those grounds. But there is evidence that the blue whale might be different. Given its great size and enormous energy requirements, the

blue whale may be forced to find winter grounds where it can do more than snack. The oasis of the Costa Rica Dome would satisfy this requirement. Plus, the productivity of the upwelling would help nursing mothers convert schools of krill into the barrels of milk required by the calves to put on their 200 pounds a day.

Balaenoptera musculus received international protection in the mid-1960s yet, for reasons not fully understood, has scarcely rebounded. If the greatest of creatures is to come back, Mate and Calambokidis believe, its demographics and its movements need to be charted. The largest remaining population of the species is most vulnerable in tropical waters where it gives birth to dainty, twenty-five-foot-long, three-ton calves.

AS WE FOLLOWED the corridor of the blue whale migration southward, we took turns standing whale watch on the bridge, searching the horizon for blows. Whales 5801 and 23043 had already arrived at the dome, according to the satellite, and number 5670 was nearing it. The scientists were particularly interested in 23043, because they knew the sex, female, and because she had arrived at the dome early, as one might expect of a mother-to-be. The white blue whale, 4172, if he was migrating to the dome this year, was out there somewhere in the host moving south. The Pacific is a big ocean, however, and we saw not a single spout.

Now and again, day and night, the ship shifted to neutral, and the researchers put gear overboard: a CTD sensor, an echo sounder, and a hydrophone. The CTD sensor recorded conductivity (a measure of salinity), temperature, and depth. The echo sounder searched for concentrations of krill, upon which the blue whale subsists almost entirely. "We're doing some control observation on the way down," Mate explained. "If there's no krill, will the whales pass through? If there are big concentrations of krill, will they hang around? We're looking for poop. We'll try to scoop it up, see if they're feeding. And checking their breath, which is fouler when they've eaten. I don't find blue



About nine months old and almost ready to weaning, a calf shadows its mother in the Santa Barbara Channel off California. The pair belongs to the world's densest group of blue whales, numbering some 2,000, which feed on krill here in the summer.



SOUTH FOR THE WINTER

North Pacific blue whales were known to winter at the Costa Rica Dome, a nutrient-rich upwelling that supports abundant krill. But its location shifts, so researchers aboard R.V. *Pacific Storm* used satellite-tagged whales to lead the way. Three of 15 whales tagged off Santa Barbara made the migration in early 2008. Others wintered off Mexico. Further tagging at the dome could confirm a hunch that blue whales from as far south as Antarctica gather at this upwelling too.

BLUE WHALE SATELLITE TRACKS

Tagged fall 2007 off Santa Barbara

- Wintered at the Costa Rica Dome
- Wintered near Mexico

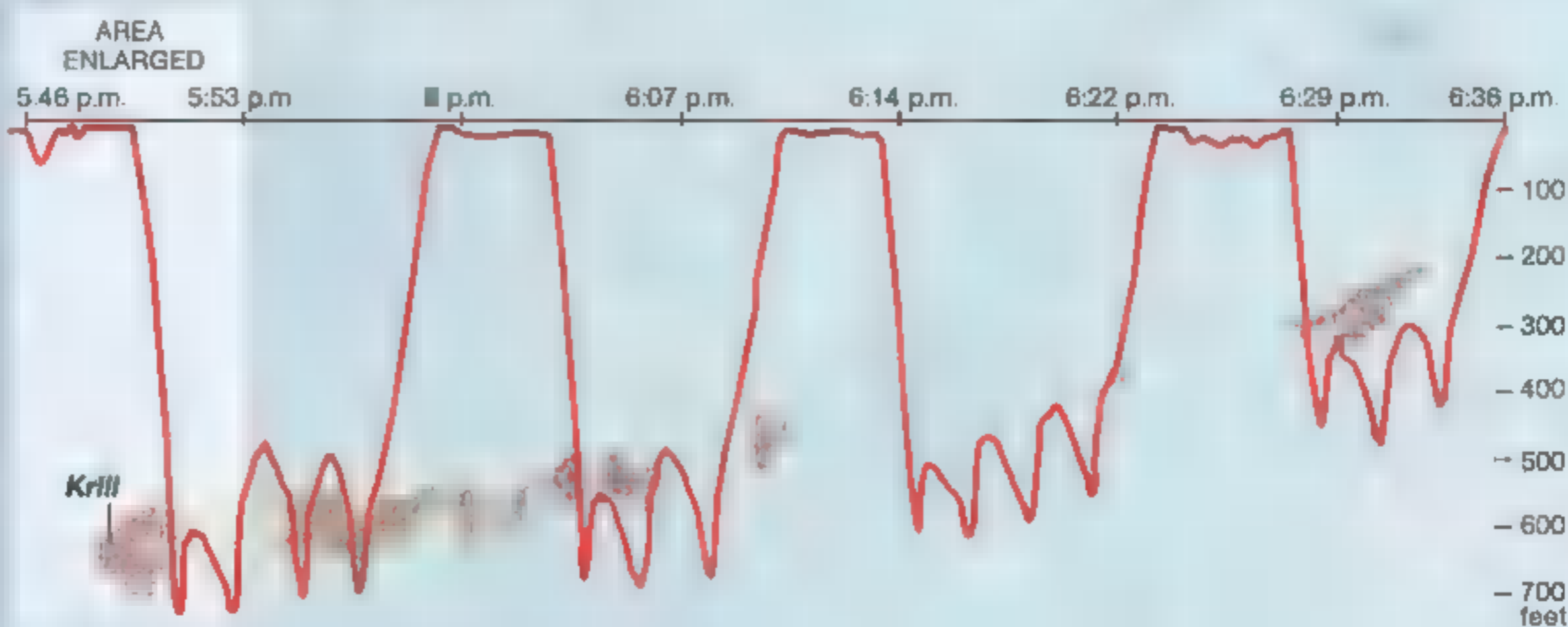
Tagged winter 2008 at the dome

- Two tagged; one returned north



DEEP FEEDING AT THE DOME

Wearing a temporary acoustic tag, a whale reveals its feeding pattern. Scientists following in a boat also used an echo sounder to track krill, which rise at dusk. Plunging deep, the whale lunges repeatedly at krill, surfaces to breathe, and begins again.



Krill
700-foot

1 SINKING HEADFIRST to past 700 feet, the whale doubles back to close in on a school of krill.

2 A LUNGE forces water and krill into the mouth, expanding the pleated throat pouch.

3 THE MASSIVE TONGUE, which weighs as much as an elephant, pushes water out of the mouth, leaving krill behind.

HIRAM HENRIQUEZ, LISA R. RITTER, AND A. R. WILLIAMS, NG STAFF
SOURCES: BRUCE MATE, MARINE MAMMAL INSTITUTE, OREGON STATE UNIVERSITY (SATELLITE TAGGING); JOHN CALAMBOKIDIS, CASCADIA RESEARCH (ACOUSTIC TAGGING)

whale breath offensive—certainly not in comparison to gray whale breath, which is really foul—but blue whale breath can be strong.”

The hydrophone was to detect blue whale voices. The simple song of the blue whale bull—the thumping, stentorian, basso profundo pulse of the A call, followed by the continuous tone of the B call—is the mightiest song in the sea, theoretically capable of propagating halfway across an ocean basin. But big baleen whales often run silent. Except for a few dubious snatches of song, we heard nothing at all.

WHEN WE REACHED the Costa Rica Dome, three days out of Acapulco, the ocean looked no different, just blue horizon and marching swells. It took a sounding by the CTD sensor to detect the thermocline lying just 60 feet under the surface. We had arrived. “Blow at eleven o’clock!” Calambokidis called down the next morning from the crosstrees, our crow’s nest, over his

its tip, the bolt was blocked by an oblong ball of yellow rubber that prevented the projectile from going in too deep and also served to bounce it off the whale.

Mounted on the rubber bow of *Hurricane* was a metal bowsprit, the “pulpit,” custom-made for this work. Each time we closed on whales, I would follow Professor Mate up onto the narrow grate of the pulpit deck. From its holster, which was a transparent plastic tube lashed to the pulpit rail, Mate withdrew the satellite-tag “applicator,” a long-barreled, red-metal blunderbuss with a wooden rifle stock. This device, originally a Norwegian invention for shooting line between ships, is powered by compressed air from a scuba tank. The pop is adjustable. For blue whales, Mate sets the dial at 85 pounds per square inch of pressure. For sperm whales, which have very tough skin, he sets the pressure at 120 pounds. Both Mate and I wore waist harnesses, which we clipped into

THE GRANDEST CREATURE IN ALL CREATION HAS BEEN HUNTED BY OUR KIND, THE THINKING APE, TO NEAR EXTINCTION. BUT IT’S HARD NOT TO FEEL OPTIMISTIC.

walkie-talkie. We saw two more blows side-by-side in quick succession—our first blue whales—and we launched the tagging boats, beginning the repetitive ritual that would occupy us for the next three weeks.

The boats were Coast Guard surplus, a pair of diesel-powered RHIBs, or rigid hull inflatable boats. Sticking with meteorological nomenclature, we called the big one *Hurricane* and the small one *Squall*. I generally went out on *Hurricane*. Its commander was Bruce Mate. The second mate, and also the second Mate, was Mary Lou, the expedition videographer and the professor’s wife of 40 years. I was the biopsy guy. My first job was to cock my crossbow, take a biopsy bolt from the cooler that served as ammunition box, nock the bolt, and then remove the sheath of aluminum foil protecting the tip from contamination by extraneous DNA. The bolt, when shot into the whale, would excise a plug of skin and blubber. About three inches back from

slings on the pulpit rail, freeing up our hands for the shooting.

The first we saw of a whale was almost always its blow.

When the sun was behind us, we sometimes saw a prismatic scatter of color in the explosive expansion of spray and vapor—a few milliseconds of rainbow—before the color shimmered out and the spout faded to white.

Whenever a blue whale surfaced to blow nearby, I was struck by the blowhole—a pair of nostrils countersunk atop the tapering mound of the splash guard, built up almost into a kind of nose on the back of the head. Other baleen whales have splash guards too, but not like this. This nose was almost Roman. It seemed disproportionately large, even for the biggest of whales. Its size explained that loud, concussive exhalation—less a breath than a detonation—and its size explained the 30-foot spout. It was a mighty blow, followed quickly by a mighty inhalation.

The second thing we saw of the whale was its back.

The blue whale is “a light bluish gray overall, mottled with gray or grayish white,” as one field guide describes it, and the back is often, indeed, this advertised color, but just as often, depending on the light, the back shows as silvery gray or pale tan. Whichever the color, the back always has a glassy shine. When you are close, you see the water sluicing off the vast back, first in rivulets and sheets, and then in a film that flows in lovely, pulsed patterns downhill to the sea.

If blue whales above water are only putatively blue, then below the surface they go indisputably turquoise. *Balaenoptera musculus* is a pale whale, and when seen through the blue filter of the ocean, its pallor goes turquoise or aquamarine. This view of the whale, downward through 20 to 50 feet of water, is for me the most haunting and evocative.

If the most beautiful hue of the blue whale is

patch lingers long after the whale is gone. “It’s a measure of how much energy is in the stroke,” Mate told me one afternoon when he caught me staring at one of these slicks. The circle of the flukeprint is perfectly smooth, except for a few faint curves that mark the continued upwelling of energy. Eventually the chop of the ocean begins to erode the slick from the outside inward, but only slowly.

The emphatic flukeprint was another of those discouraging signs that caused us to call off a chase. “Holy smokes!” Mate said one afternoon, as we motored into the middle of a huge one. Ladd Irvine, a research assistant who served as helmsman, laughed in admiration: “We’re not going to see him again for a while.”

Out on the pulpit, the professor spread his feet for balance, rested the butt of his applicator on the grating of the pulpit deck, and gripped the barrel just below the muzzle-loaded, chiseled tip of his satellite tag. His quick-dry khaki

HAD JONAH BEEN INJECTED INTRAVENOUSLY, HE COULD HAVE SWUM THE ARTERIAL VESSELS OF THIS WHALE, BOOSTED ALONG BY THE SLOW, GODLIKE PULSE.

turquoise, then the most beautiful form, the finest sculpture, is in the flukes. In the first week of our tagging efforts, the tail always seemed to be waving goodbye. “Ta-ta,” it signaled. “Nice try. Better luck next time.” When a whale showed its flukes—when the two palmate blades poised high in the air—we would break off the chase, because elevated flukes meant a deep dive.

But sometimes we saw the flukes close under the surface. They were huge, wider than the boat, and in motion they were hypnotically lovely. “In no living thing are the lines of beauty more exquisitely defined than in the crescentic borders of these flukes,” Melville writes in *Moby Dick*.

The last thing we saw of the whale was its “flukeprint.”

When a whale or dolphin swims at shallow depths, turbulence from its flukes rises to form a circular slick on the surface: the footprint or flukeprint. The flukeprints of blue whales are large and surprisingly persistent. The smooth

pants luffed and billowed in the sea wind, and now and again the breeze brought a powerful smell of staleness and mold, mixed sometimes with an alarming flatulence. Whew, Bruce! I thought on more than one occasion. Then one day, as the wind rippled in his khakis and we closed in on the spout ahead, the professor emitted a blast so powerful, inhuman, and malodorous that I realized he had to be completely innocent. What I had been smelling, all along, was not our leader. I had been smelling the bad breath of blue whales.

For almost a week at the dome, every whale slipped away from us. On our sixth day our luck changed. We saw three spouts to the southeast that morning and launched *Hurricane*.

The first two whales toyed with us, as usual, allowing us close, then pulling away. The third allowed us to get in perfect position. We paced the great turquoise shape, keeping abreast of the flukes as the whale coursed along underwater

Lunging backward at the surface, a whale positions its lower jaw to scoop water and krill into its pleated pouch (top), which can quadruple in size. As a whale expels water from its pouch (bottom), krill catch on the baleen edging the roof of its mouth.

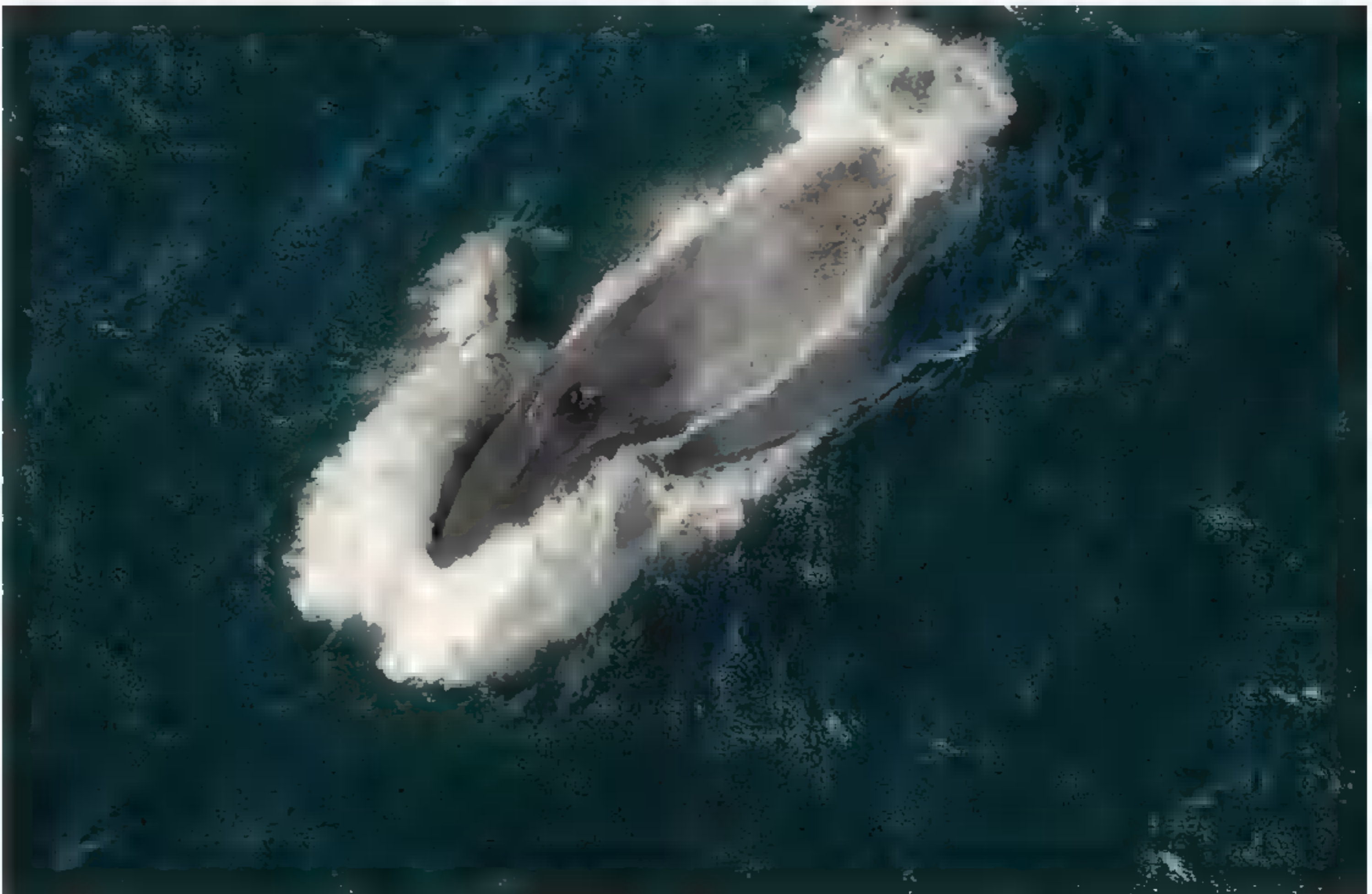




While tagging whales from their 85-foot-long vessel in the Santa Barbara Channel in 2007, scientists discovered a body floating belly-up. An autopsy revealed fatal injuries from a collision with a ship—probably one speeding cargo in or out of Los Angeles. Speed limits and relocating shipping lanes could help save lives.



The noselike splash guard atop ■ whale's head (below) diverts water from two blowholes, each big enough for a toddler to crawl in. Surfacing with a splash (bottom), ■ whale exhales, then inhales enough air to fill a van, all in a second and a half.



to starboard. As the animal surfaced to blow, it angled up from turquoise abstraction into photo-realism. Irvine gunned the engine. Up in the pulpit I clicked off my crossbow's safety. Mate tucked the rifle stock of the tag applicator into his shoulder, leaned outward over the pulpit rail, and aimed the long, red barrel almost straight downward at the rising whale, now just ten feet underwater. The whale blew, and the glistening wall of its flank erupted in a steep curve above the sea.

My instructions as biopsy guy were to wait for the bang of the tag applicator before firing my crossbow. The smooth flank of the whale filled my whole field of view; there was no way I could miss. At the bang of the applicator, I pulled my trigger. The bolt left the crossbow, and a black hole, small but inky, appeared where I had been aiming. It took a millisecond for me to understand that I was responsible for it, and I felt a pang of regret and guilt. I did that? I thought,

falling upward. "Bubble blast," observed Mate.

This particular bubble blast seemed to be commentary directed at our persistent and irritating little boat—some kind of whale expletive, probably. It rose above the whale's head like a speech balloon in a Gary Larson cartoon. Its message was something like "@*#&%√!?!"

Of all the marks of blue whale cursive, the most colorful was the defecation trail. The first defecation we saw was in a yearling, a little 50-footer. This whale blew 40 yards away, and behind it the ocean brightened in a long, red-orange contrail. "We have a defecation," Irvine announced. This contrail, a brick red streak of processed krill, more watery than particulate, was our first direct evidence that blue whales were feeding in winter at the Costa Rica Dome. As this was one of the hypotheses this expedition had been launched to test, Mate scrambled to find a Ziploc bag to collect a sample.

The evidence for feeding that we observed

THE SONG OF THE BULL, THE STENTORIAN PULSE OF THE A CALL, FOLLOWED BY THE CONTINUOUS TONE OF THE B CALL, IS THE MIGHTIEST SONG IN THE SEA.

like a boy whose pop fly has gone through a stained-glass window.

Then my sense of proportion returned. In relation to the vastness of this whale, my hole was just a mosquito bite. This was not a crime; it was a blow for science. On the pulpit, Mate and I unclipped our harnesses and shook hands.

THE BLUE WHALE writes a kind of longhand on the surface of the sea. There is the ovoid slick that forms above the head the moment before emergence, the long, narrow slick left by the arching back, and the circular slick of the flukeprint. There are the sputtering white fountains that a blue whale raises by blowing early, still gliding under the surface—a sequence of premature spouts. There are bubble blasts. I saw my first of these just ahead of the bowsprit, about 12 feet deep, as the blowhole of a whale erupted a big bolus of bubbles. It expanded toward the surface, vitreous and glittery, like a crystal chandelier

firsthand in the defecation trails was corroborated in the ship's laboratory. On her computer screen, Robyn Matteson, Mate's graduate student, monitored the echo sounder and the concentrations of krill it detected at the dome. Krill distribution was patchier than anyone had imagined, but dense schools of the small crustaceans were plainly here. Across the lab table, at their own computers, Calambokidis and Erin Oleson of Scripps Institution of Oceanography studied the dive profiles recorded by acoustic tags they had succeeded in applying to several whales. The acoustic tags, deployed by pole and attached by suction cups, stay on the whale for hours, not months, like the more invasive satellite tags. Here at the dome, the depth recorders on the tags showed dives to 800 feet and deeper. The vertical line marking each dive, on reaching its greatest depth, began to zigzag in the sawtooth pattern characteristic of blue whales when lunge feeding on krill.

The evidence for calving at the Costa Rica Dome proved more elusive, but after many fruitless days, it arrived finally, to starboard, by way of a mother and her calf.

The pair were moving slowly, spending a lot of time at the surface. The mother surprised us by allowing her calf to turn toward *Pacific Storm*. A mother whale often interposes herself between her calf and potential danger, but this mother was an easygoing, Montessori sort of parent, and she let her baby explore.

John Calambokidis drove *Squall* out to snap surface pictures for photo identification. Nicklin and cameraman Ernie Kovacs grabbed their gear and went along. On nearing the whales, they pulled on their fins and slipped overboard. At first they saw nothing through their dive masks but blue. Then Kovacs, looking for the youngster, was startled to see it pass, maybe five feet below his fins. This whale was just a baby, yet its blue back seemed to pass under him

one of these telemetric whales, we had found it in the company of “clean” whales. Satellite tagging had proved itself an efficient method for locating concentrations of the untagged. We had satellite tagged three new blue whales (but one tag failed to transmit), affixed acoustic tags to six more, and photo identified about 70. Thirteen of those 70 were from California. The voyage proved that the dome is visited by large numbers of blue whales. We saw many threesomes, the romantic triangles of the blue whale, and we witnessed much boisterous courtship behavior, all suggesting that the dome is a mating ground. We demonstrated beyond a doubt that blue whales do feed here in the winter. With sonobuoys and acoustic tags, we eavesdropped on A and B calls of the blue whale song and on the D calls whales make between bouts of feeding, and thus began notation of the winter music in this patch of ocean.

The news from the dome is good.

IF THE MOST BEAUTIFUL HUE OF THE BLUE WHALE IS TURQUOISE, THEN THE MOST BEAUTIFUL FORM, THE FINEST SCULPTURE, IS IN THE FLUKES.

endlessly. The calf, gliding by Nicklin, rolled slightly to bring an eye to bear on him. It peered into the glass orb of the camera housing, and Nicklin's shutter winked back.

AFTER 21 DAYS at the Costa Rica Dome, we could stay no longer and turned north for Acapulco.

On the voyage home, we took stock. There had been disappointments: We wished we had satellite tagged more whales, had seen more calves, had experienced more underwater encounters with blue whales. We were sorry not to have glimpsed whale 4172, the white bull. But for the most part we were satisfied.

In three weeks spent crisscrossing the dome, we had succeeded in finding three whales satellite tagged in California and tracked down here. Each time we homed in on the transmissions of

The grandest creature in all creation has been hunted by our kind, the thinking ape, to near extinction. Its numbers still are low, but it was hard not to feel optimistic. In my bunk with Nicklin's laptop, lingering over his digital portraits of the curious calf, I thought I could read, in its strange visage, a gargantuan impishness. I found this cheering. The young do give us hope.

On the voyage home, we found time for reflection, and I understood why the blue whale's flukeprint so mesmerized me each time I saw it at the dome. That big, circular slick is the signature of the species, the John Hancock of flukeprints, outsize and insistent. It jumps out boldly from the parchment. Its uncanny persistence on the sea's surface, defying the choppiness, is a good omen. Appearing at the dome, this winter haven, it suggests that the blue whale might after all defy the chop of history.

“Still here!” the flukeprint says. □

Society Grant This research project was funded in part by your Society membership.



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Changing Bulbs

The light-emitting diode (LED) looks like the eco-bulb of the future. With no filament, just a microchip, it uses significantly less energy than an incandescent. But the price is high and reviews are mixed. LED illumination can range from warm to what technology analyst Michael Kanellos calls "alien autopsy." The bulb casts its light in only one direction, which is fine for recessed lights and for spotlighting a specific area but could be a drawback in lamps or globes. In a few years, expect a cheaper, more versatile LED. Until then, experts recommend compact fluorescents (CFLs) for most home use—with a note of caution. Their mercury content calls for disposal as hazardous waste. —Linda Kulman



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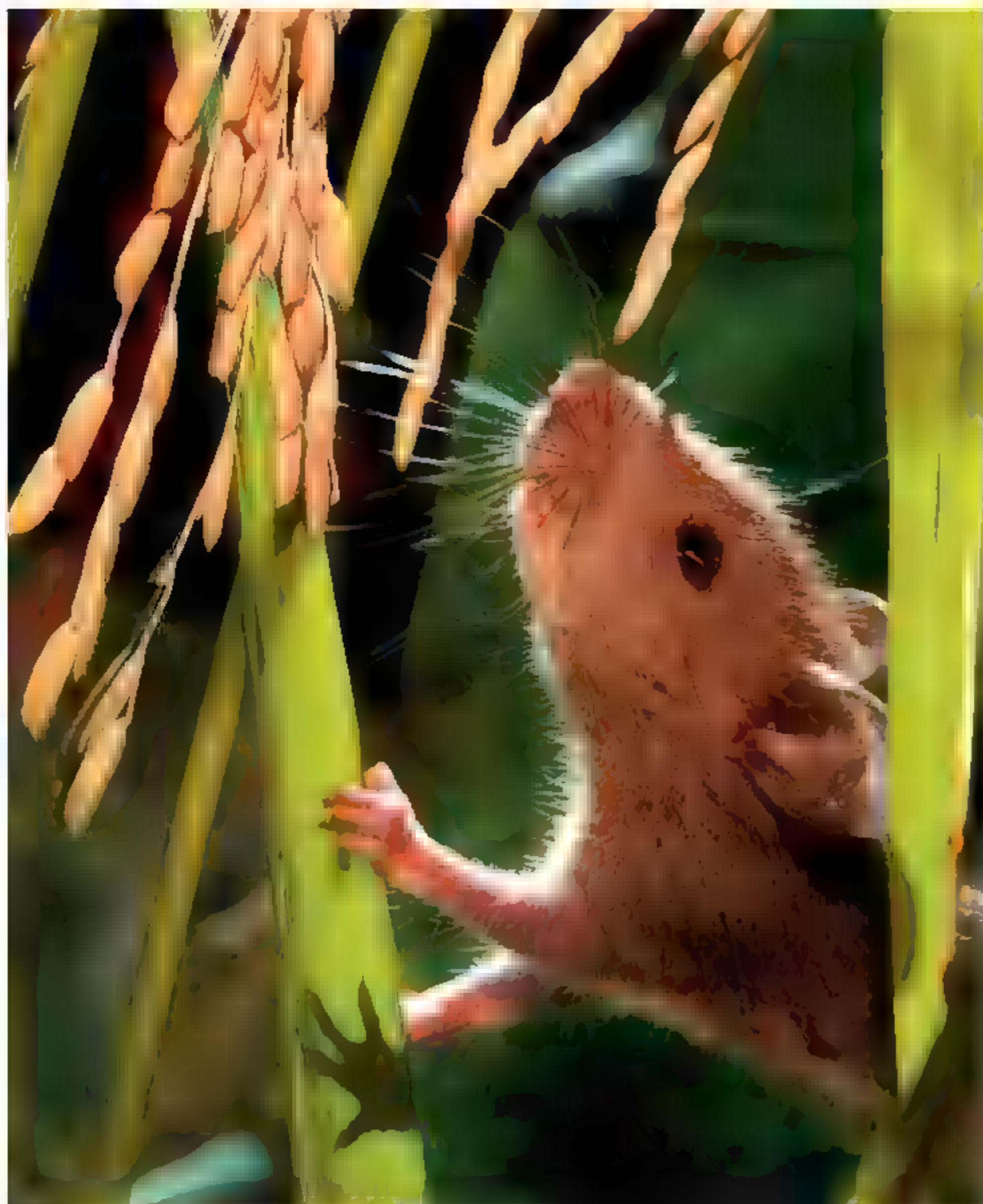
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INDIA Rats on a Rampage Throughout Asia bamboo is revered as a symbol of good fortune. But one bamboo species causes dread. It flowers every 50 years in India's Mizoram state—and its blooming brings tens of millions of hungry rats. After they devour the bamboo fruit, the rats demolish precious crops like rice (above). Biologist Kenneth Aplin is the first scientist to study links between Mizoram's rat outbreak and the bamboo. "They breed non-stop because there's so much food," he says. The region's previous rat outbreak, in the 1950s, led to famine and political upheaval, but disaster relief has tempered the effects of the current season, which began in late 2006 and continued through 2008. Once the bamboo fruiting subsides, so will the rat menace—until about 2057, when Aplin's successors can continue his work. Northeast India's rat outbreak is featured in *Rat Attack*, a NOVA–National Geographic special on PBS airing February 24. Check local listings for times.

BOTSWANA

It's well-known that animal diseases can pass to humans. Veterinarian **Kathleen Alexander** documents the reverse: the first cases of a human disease, tuberculosis, emerging in free-ranging wildlife—the mongoose. Understanding this outbreak will help conservation.

TURKEY

Nautical archaeologist **Deborah Carlson** excavated a 2,100-year-old ship in the Aegean and found it loaded with 50 tons of marble. The cargo's elusive destination: a temple dedicated to Apollo.

EARTH'S MOON

Astrophysicist **Arlin Crotts** discovered a link between radioactive radon gas and mysterious flashes from the moon. Using robotic telescopes, he and his team map this lunar activity.

MEXICO

Archaeologist **Gary Feinman** seeks clues to the fall of the Zapotec civilization. Not even a mighty rain god (right) could save agrarian centers from collapse 1,200 years ago.

**This Year in NGS History****1961**

Primatologist **Jane Goodall**, the first to document tool-making by a nonhuman species, continued her observation of chimpanzees in Tanzania using twigs and branches to rustle up a snack of termites.

ON ASSIGNMENT Hot Shots Photographer Tyrone Turner wasn't doing anything nefarious. For this month's story on energy conservation, he used an infrared camera (below) to take pictures of heat leaking from houses, cars, and the Brooklyn Bridge (bottom). The camera, typically employed to find overheating machinery, shows temperature; red is hottest and blue is coldest. The problem is that it looks like a video camera, and to get the best pictures of houses, Turner had



to work in the cold, sometimes in the middle of the night. He also had to take dozens of pictures from the same spot, so he couldn't get up to explain when a neighbor at one house came out to write down his license plate number. "It's not like I was trying to hide from anyone," says Turner. "I'd be standing in the middle of the street." He managed to finish the story without being arrested.

PEOPLE BEHIND THE STORIES

■ **Matthew Teague** The writer of this issue's "The Sinai" summited Mount Sinai at dawn—and nearly "lost his religion," he says, trying to do so. He was also beaten to the top by choir-singing nuns. "Only the irony saved me," says Teague. "But then the sun rose, the light washed over us, and everything seemed all right."

■ **Kenneth Brower** To write about blue whales in "Still Blue," Brower spent days and nights at sea. He says it was oddly calming, even in a storm. "In our bunks," he says, "we were in constant movement. For the seasick, it was awful. But I was 'seawell' and found myself soothed. I wondered how I ever slept without it."



An infrared image made on a cold day shows Manhattan's sky as dark blue.



A blue whale can
swim as fast as
20 miles per hour.



Blue Giant Its heart is the size of a small car, its song travels hundreds of miles, and it has powerfully stinky breath. Much is known about the blue whale, the biggest animal on Earth, but questions remain. Where do blue whales breed? Are they being illegally hunted? What sounds do they hear? The National Geographic Channel show *Kingdom of the Blue Whale* joins a boatload of researchers on the trail of answers. Scientists attach satellite tags to whales off California, then travel south to look for the animals' breeding grounds. One whale even helps out as a cameraman with a video camera suction-cupped to its back. The program airs March 8; check local listings.

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Nel Cepeda

Pat Minnick included National Geographic in her financial plans.

Give An Inspiring Gift

In 2007 Pat Minnick, a professional artist, decided to establish a charitable gift annuity to support National Geographic. She now receives a guaranteed life income and is a direct part of the Society's efforts to inspire people to care about the planet.

"I feel good knowing that National Geographic is doing so much to protect endangered wildlife," says Pat. "The environmental problems we face are vast, but by joining with National Geographic and their history of remarkable accomplishments, I know we can pass on a more beautiful world."

For more information about a charitable gift annuity or other ways to include National Geographic in your estate plans, please contact the Office of Gift Planning.

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Amish mantle and miracle invention help home heat bills hit rock bottom

Miracle heaters being given away free with orders for real Amish fireplace mantles to announce the invention that helps slash heat bills, but Amish craftsmen under strain of winter rush force household limit of 2

Save money: only uses about 8¢ electric an hour; so turn down your thermostat and never be cold again

By MARK WOODS
Universal Media Syndicate

(UMS) Everyone hates high heat bills. But we're all sick and tired of simply turning down the thermostat and then being cold.

Well now, the popular HEAT SURGE® miracle heaters are actually being given away free to the general public for the next 7 days starting at precisely 8:00 a.m. today.

The only thing readers have to do is call the National Distribution Hotline before the 7-day deadline with their order for the handmade Amish Fireplace Mantle. Everyone who does is instantly being awarded the miracle heater absolutely free.

This is all happening to announce the HEAT SURGE Roll-n-Glow® Fireplace which actually rolls from room-to-room so you can turn down your thermostat and take the heat with you anywhere. That way, everyone who gets them first can immediately start saving on their heat bills.

Just in time for winter weather, portable Amish encased fireplaces are being delivered directly to the doors of all those who beat the deadline.

These remarkable fireplaces are being called a miracle because they have what's being called the 'Fireless Flame' patented technology that gives you the peaceful flicker of a real fire but without any flames, fumes, smells, ashes or



■ **GENUINE AMISH MANTLES MADE IN THE USA:** Everyone wants to save money on heat bills this winter, so entire Amish communities are working from the crack of dawn to finish. These fine real wood Amish made fireplace mantles are built to last forever. The oak mantle is a real steal at just two hundred ninety-eight dollars because all those who beat the order deadline by calling the National Hotline at 1-800-918-4312 to order the fireplace mantles are actually getting the imported hi-tech Fireless Flame HEAT SURGE miracle heaters for free.

mess. Everyone is getting them because they require no chimney and no vent. You just plug them in.

The Fireless Flame looks so real it amazes everybody because it has no real fire. So what's the catch? Well, soft spoken Amish craftsmen who take their time



■ **JUST ANNOUNCED:** The Heat Surge miracle fireplace has earned the prestigious Good Housekeeping Seal. The product has earned the Seal after evaluation by the Good Housekeeping Research Institute.

hand building the mantles have a process that forces a strict household limit of 2 to keep up with orders.

"We can barely keep up ever since we started giving heaters away free. Now that it's really cold outside, everyone's trying to get them. Amish craftsmen are working their fingers to the bone to be sure everyone gets their delivery in time to save a lot of money," confirms Timothy Milton, National Shipping Director.

"These portable Roll-n-Glow Fireplaces are the latest home decorating sensation. They actually give you ■ beautifully redecorated room while they quickly heat from wall to wall. It's the best way to dress up

every room, stay really warm and slash your heat bills all at the same time," says Josette Holland, Home Makeover Expert.

And here's the best part. Readers who beat the 7-day order deadline are getting their imported hi-tech miracle heaters free when encased in the Amish built real wood fireplace mantles. The mantles are being handmade in the USA right in the heart of Amish country where they are beautifully hand-rubbed, stained and varnished.

You just can't find custom made Amish mantles like this in the national chain stores. That makes the oak mantle a real steal for just two hundred ninety-eight dollars since the

HEAT SURGE® Fireless Flame

How It Works: The HEAT SURGE miracle heater is a work of engineering genius from the China coast so advanced, you simply plug it into any standard outlet. It uses only about 8¢ of electric an hour on the standard setting. Yet, it produces up to an amazing 5,119 BTU's on the high setting. So watch out, a powerful on board hi-tech heat turbine silently forces hot air out into the room from the vent so you feel the bone soothing heat instantly. It even has certification of Underwriters Laboratories coveted UL listing. It also comes with a limited full year replacement or money back warranty plus a 30-Day Satisfaction Guarantee.



Hot air only comes out of the top vent



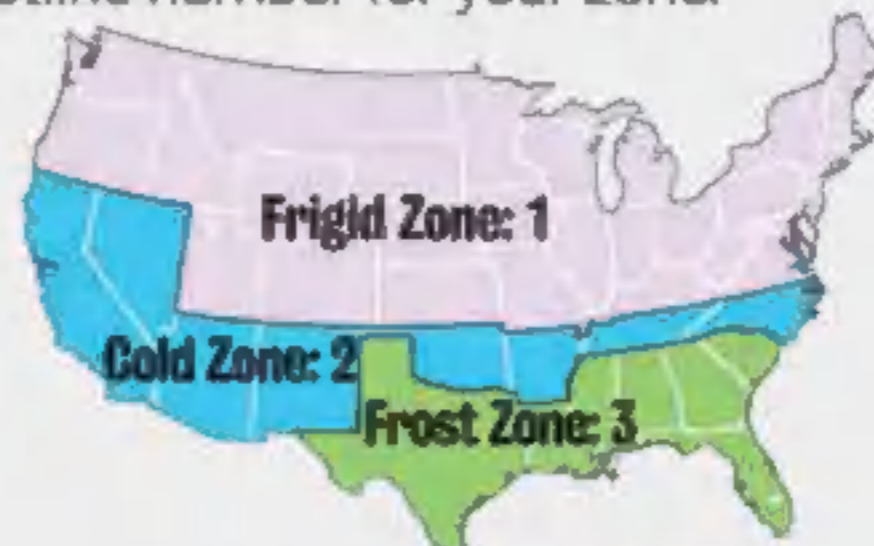
The hi-tech silent heat turbine takes in cold air

How to get 2 free heaters

The National Toll Free Hotlines are now open. All those who beat the 7-day order deadline to cover the cost of the Amish made Fireplace Mantle and shipping get the HEAT SURGE miracle heater free.

A strict limit of 2 per household has been imposed. Since some home woodworkers want to build their own mantle piece, they are letting people get the imported miracle heater alone for just \$249. Or, with the Amish made mantle you get the miracle heater free.

Use the map below to locate the weather zone you live in and call the Hotline number for your zone.



Claim Code: FP7994

EVERYONE LIVING IN THE Frigid Zone: 1
START CALLING AT 8:00 A.M. TODAY
1-800-918-4312

EVERYONE LIVING IN THE Cold Zone: 2
START CALLING AT 8:30 A.M. TODAY
1-800-716-2513

EVERYONE LIVING IN THE Frost Zone: 3
START CALLING AT 9:00 A.M. TODAY
1-800-695-3077



ON THEIR WAY: Winter rush orders have turned country roads into pipelines to the big city delivery system. Everybody wants a fireplace that comes fully assembled with a handmade Amish mantle in oak or cherry finish and gets delivered by truck right to your door. All you do is plug it in.

entire cost of the miracle heater is free.

This free giveaway is the best way to slash heating bills and stay warm through the dead of winter. The HEAT SURGE Roll-n-Glow Fireplace gives you zone heating and all the beauty and warmth of a built-in fireplace but rolls from room-to-room so it can also save you a ton of money on heating bills.

Even people in California and Florida are flocking to

get them so they may never have to turn on their furnace all winter. And since it uses only about 8 cents of electric an hour on the standard setting, the potential savings are absolutely incredible.

"We are making sure no one gets left out, but you better hurry because entire communities of Amish craftsmen are straining to keep up with demands. For now, we are turning away all dealers in order to let readers have two per household

just as long as they call before the deadline," confirms Milton.

It's a really smart decision to get two right now because for only the next 7 days you get both miracle heaters free. That's like putting five hundred bucks right in your pocket and you can save even more money on your monthly heating bills.

"Everyone's calling to get one but those who really want to save a lot of money are surprising the

whole family by getting two. So when lines are busy keep trying or log onto amishfireplaces.com. We promise to get to every call. Then we can have a delivery truck out to your door right away with your beautiful Heat Surge Roll-n-Glow Fireplace," Milton said.

"You'll instantly feel bone soothing heat in any room. You will never have to be cold again," he said. ■

On the worldwide web:
www.amishfireplaces.com

Rolls anywhere to throw an instant heat wave with no chimney, no vents, no wood and no smoke



EASILY ROLLS ANYWHERE: This is the portable Roll-n-Glow® Fireplace that easily rolls from bedroom to living room to keep you warm. No vents, no chimney and no tools. Just plug it in.



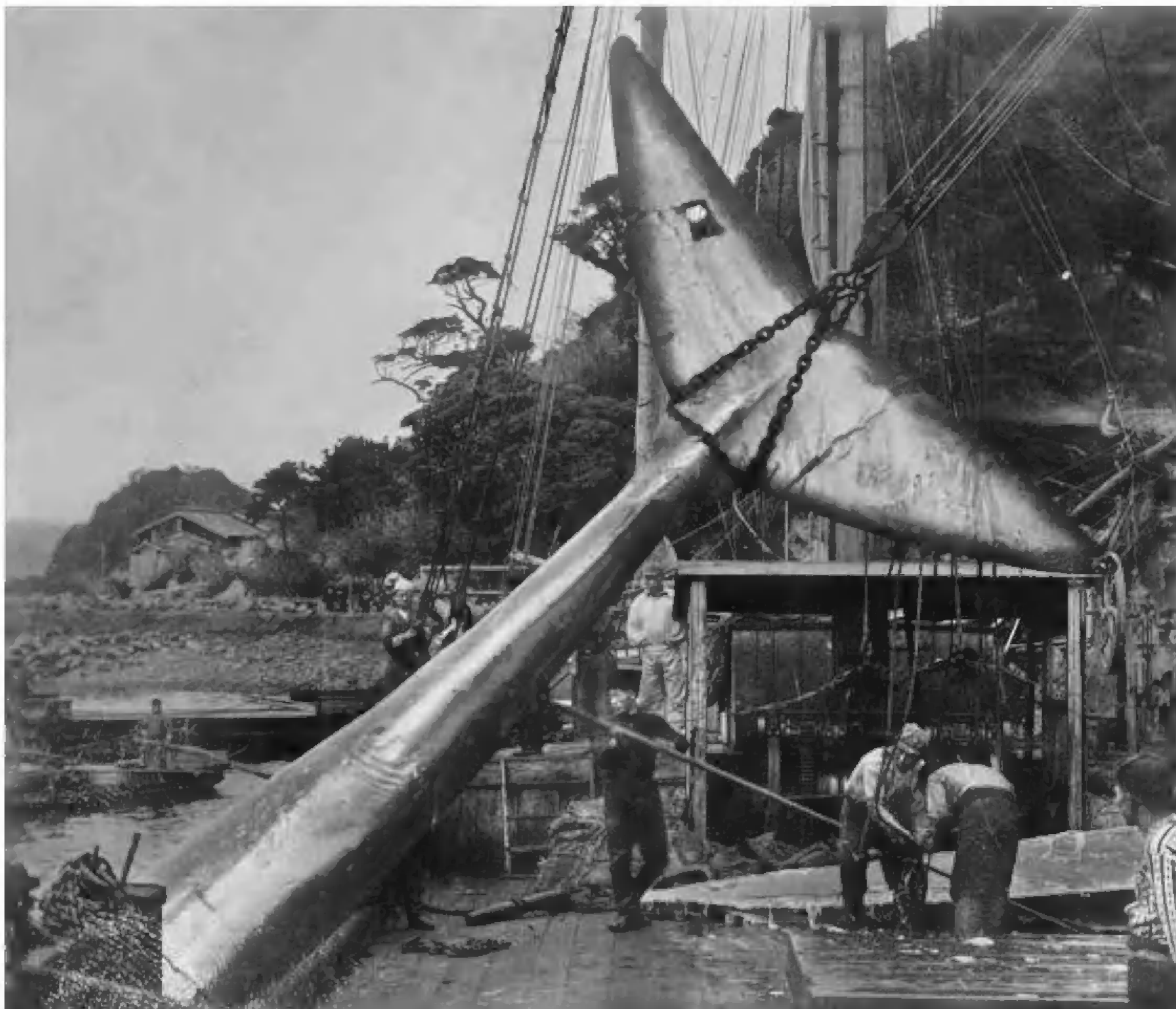
SAVES ON BILLS: Everyone can get low bills and stay warm and cozy. The new Roll-n-Glow Fireplace saves a ton of money and makes your front room look like a million bucks.



SAFE FLAME: The Fireless Flame looks so real it fools everyone but there is no real fire. That makes the flame window safe to the touch under the watchful eye of a parent. It's where the kids will play and the cat and dog will sleep.



FREE: Get this \$249 miracle heater free. It is being given away free to all who beat the 7-day order deadline for your choice of the oak or cherry finish Amish Mantles. The free heater comes already encased.



Tail's End "Again and again Sorenson lanced him, each time remaining a little longer and jabbing the lance deeper into his body. At last the gallant animal threw his fin into the air, rolled on his side, and sank," wrote Roy Chapman Andrews of a finback whale hunt in his 1916 book *Whale Hunting With Gun and Camera*. Parts of the text ran in the May 1911 *Geographic*, which featured this photo of a finback's tail being hoisted at a Japanese whaling station. In the magazine, Andrews described the scene at one such station: "The entire posterior part of the whale was then drawn upward and lowered on the wharf to be stripped of blubber and flesh.... Section by section the carcass was cut apart and drawn upward to fall into the hands of the men on the wharf and be sliced into great blocks two or three feet square." —Margaret G. Zackowitz

👉 **Flashback Archive** Find all the photos at ngm.com.

PHOTO: ROY CHAPMAN ANDREWS, NATIONAL GEOGRAPHIC STOCK



INVESTING FOR A GREENER FUTURE.



INTEL RECOGNIZED BY EPA AS GREEN POWER PARTNER OF THE YEAR.

Intel is currently the single largest purchaser of renewable energy certificates in the U.S. We believe that this investment will stimulate the market for renewable energy and a greener future. Learn more at intel.com/inside

GREAT COMPUTING STARTS WITH INTEL INSIDE.

Nearly one third of teens admit to texting while driving.



SOME OF THEM WILL NEVER BE HEARD FROM AGAIN.



Car crashes are the leading cause of death among American teens. **Is any text message worth that risk?**

A recent survey showed that teens consider texting while driving to be extremely distracting. Texting not only takes their minds off the road but also takes their hands off the wheel.

Allstate has a few ideas to help curb the epidemic:

USE THE LAW.

Support state legislation banning digital distractions. The State of California has now banned anyone under the age of 18 from using cell phones, laptop computers, pagers or any text-messaging device while driving.

STRENGTHEN GRADUATED DRIVER LICENSING (GDL) LAWS.

GDL laws put limitations on teen driving so kids can gain experience safely. Since North Carolina

implemented one of the most comprehensive GDL laws in the country, it has seen a 25% decline in crashes involving 16-year-olds.

HAVE THE DRIVING TALK.

75% of teens surveyed said their parents would be the best influence in getting them to drive more safely. The Allstate Parent-Teen Driving Contract can help start the conversation. **Contact an Allstate Agent to get a copy or visit Allstate.com/teen for the interactive contract.**

Let's help teens realize the importance of giving the road their undivided attention.

It's time to make the world a safer place to drive.
THAT'S ALLSTATE'S STAND



Allstate
You're in good hands.

Auto
Home
Life
Retirement